Engineering Record

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Local Financing of City Work

SINCE the outbreak of the European War this journal has twice suggested that city officials appeal to local bankers to finance immediate needs. Officials in a number of cities have proceeded along these lines and, despite the condition of the bond market, have been able to proceed with their projects. The experience of New York City was noted editorially in this journal some time ago, and more recently the bankers of Paterson, N. J., agreed to advance to the city at 6 per cent $400,000 needed for meeting immediate obligations. The suggestion is worth repeating for the benefit of those cities which are having difficulties on account of the financial stringency. Local pride is a factor to be reckoned with and can be turned into an asset in the present juncture.

Consideration for Utility Companies

THERE is a corollary, also worthy of comment, to the view expressed in the preceding note. Cities which are having financial difficulties themselves should extend to the public service corporations under their control the same consideration that they expect. It may be highly desirable, to serve a growing section of a city, to have a street car line extended for a mile or two, and the demands from residents of the given locality may be so insistent that city officals find it difficult to treat the corporation as their personal feelings would dictate to be proper at the present moment. Such situations call for the display of stamina. It is not easy to stand out against the popular cry, but certainly fair treatment to the municipal utility corporation demands it at the present time. Conditions are properly appreciated in some communities, as is evidenced from a statement made to this journal last week by an official of a company controlling a number of waterworks plants. This company has explained frankly to the city officials its financial situation and has asked that extensions ordered and agreed upon before the war be postponed indefinitely. Almost without exception, the officials have seen the justice of the request. This is, indeed, a hopeful sign—another evidence of a more rational consideration of the rights of utility corporations than was evident some years ago, when railroad baiting was at its height.

Sugar Factory Wastes

TREATMENT of highly putrescible trade wastes is generally put off until the nuisance becomes so unbearable that nearby residents ply the Board of Health with complaints. When the odors are at their worst and all temporary expedients have been tried, the sanitary engineer is called in to build something in a hurry. In the treatment of sugar factory wastes discharged at the Southern California plant referred to on page 462, there seemed to be no precedent, at least for the conditions there obtaining. So far as known, the comprehensive investigations described are among the first undertaken by sanitary engineers and the results have proved so successful that engineers having similar problems will be interested in watching further operation of the plant to see whether good results will continue to be obtained year after year.

Slide at Culebra

ENGINEERS will not be disturbed by the slide which blocked the waterway through the Culebra cut on Wednesday afternoon, Oct. 14. Slides were expected during the early days of the use of the canal, and they will not entirely cease until the sides of the huge cut have reached equilibrium. Colonel Goethals reports that the new slide blocked a length of waterway of about 1000 ft., but that, up to Oct. 16, there was no further movement. It was expected that the waterway would be in service again in about a week. It is worth noting, in connection with this occurrence, that the newspapers of the country have taken the matter very calmly. This is indeed fortunate, for such occurrences are usually made the text for scare heads and rumors about engineering mistakes. It is fortunate that the authorities in charge of the canal gave information freely to the press, thus forewarning all publicists that the slides were to be expected. This may well be considered by public officials who have been troubled by the pernicious activities of unthinking and uninformed newspaper men. "Publicity" has been adopted as a slogan by many corporations which, ten years ago, were unusually secretive. Public officials in charge of public works might well follow their example.

Financial Conditions Mending

REFERENCE was made in these columns some weeks ago to the improvement of financial conditions. Since then still further evidence has come to hand. On Oct. 15 the First National Bank of New York took the lead among financial institutions of the metropolis in establishing the first market for call money secured by stock-exchange collateral that has existed since the exchange closed on July 30. Beside renewing these operations, the bank reduced the rate for funds on call from 8 to 7 per cent, the former interest charge having been in force since July 30 on most call loans outstanding on that date. Following this move of the First National, other institutions made similar announcements and reduced their rate to 7 per cent, which has subsequently gone down to 6. Moreover, ninety-day loans are obtainable in some banking quarters in New York at 6 per cent. This improvement of conditions in New York is paralleled elsewhere, and persons desiring loans in moderate amounts have had no difficulty in securing funds. English conditions, it may be noted, are increasingly more satisfactory. Sir George Paish, formerly editor of the "Statist" and now advisor to the British treasury, upon reaching New York from England Oct. 16, declared that bills were being discounted freely and that there was plenty of money available for all legitimate needs. When the suspension of all relations between England and Germany and Austria is considered, this is a remarkable showing and should encourage those who have not yet been able to see the improvement in our domestic situation.

Cowardly Advertising

THERE has come to this journal a collection of reprints of newspaper and magazine clippings derogatory to concrete roads. It was sent in an unsealed envelope from the Hudson Terminal Station, New York City, and none of the clippings gives any clue as to the sender. Some of the material is entirely fair, expressing legitimate doubts as to the ultimate success of concrete as a paving material, but most of the items emanate from those who do not desire to be fair or who are densely ignorant in paving matters. Upon inquiry the Engineering Record learns that this material has been sent broadcast. Protest against it is likely to be in vain because those who are sending it out are not apt to be influenced by arguments in favor of adherence to decent business standards. One can have respect, of a certain kind, for a man whose acts are wrong but who stands up and admits his responsibility. He can have no respect, however, for the scamp who refuses to fight in the open but uses the "knife in the back" method made notorious by the Black Hand. The Engineering Record believes, further, that no good comes from this sort of advertising. Thinking men know that it is prompted by malice and will discount very largely what it says. Destruction has the same effect in business as in war. The net result is a loss, never a gain, and seldom does any contender reap an adequate advantage. Promoters of paving materials should work constructively, so that the total amount of work done each year will increase. Wholesale condemnation of a paving material widely approved, as is indicated by the large mileage of concrete roads being constructed this year, is a discouragement to further extension. The mere fact that there are only two expressions in these reprints favoring other types of material, and one of these merely casual, does not change the situation. It is a cowardly procedure and will eventually react on the heads of those responsible. The Engineering Record has been unable to find a clue as to the guilty party. If any of its readers had information this journal would be glad to receive it.

Municipal Relief for the Unemployed

THE municipal employment of men out of work has already brought about conditions in several cities which are worse for the community as a whole than those existing before this form of relief was commenced. It is due to the general belief, wholly wrong, that any man in good health is fit for employment on any kind of public work where what is termed skilled labor is not required. Needy men of good reputation have been given places in experienced gangs, with the result that the efficiency of these gangs has been greatly lowered. It is not the fault of the new men; anybody who has seen them come out of a trench after a few days of such unaccustomed work, with hands bleeding, backs bent and faces drawn, does not need to be told that they are doing their best to earn their pay. It is not the fault of the foremen, who know that unless the new men are helped to do their best, the records of their gangs will drop and consequently their records for securing low cost and efficiency be injured. It is not the fault of the superintendents, who always do their utmost to place these men, unexpectedly thrust on their payrolls, where they can give a good account of themselves.

The trouble lies in the entire absence of knowledge of what classes of work these men can perform most profitably to the city. The needs of a city are manifold. It is often just as advisable for some of its clerical work to be brought down to date as for its public works to be extended. Every need should be considered a possible opportunity.

It might as well be openly acknowledged at the beginning of municipal aid of this kind that no city officer trying to do good work wishes these inexperienced men in his department. Wherever they are put loss of efficiency results for a time. That is inevitable and the real municipal problem is to find out what classes of work can be performed by such raw recruits with the least disturbance of existing conditions and the greatest permanent returns for the money spent in relief. The problem is not the same in any two cities; it has already assumed troublesome proportions in several. In one case, where an attempt was made to solve it by displacing alien laborers by unemployed citizens, an important department was reduced to a condition of deplorable confusion by the inability of men trained only in clerical or selling work to perform manual labor efficiently.

The problem of the unemployed was a troublesome one last winter for the cities and it will apparently be as troublesome during the cold season now drawing near. It cannot be solved in the hasty and sometimes fretful way heads of departments have usually attempted to solve it. It is something for the mayor and his staff to discuss in its broad features, and for heads of departments to investigate. Only then will relief work be handled to the best advantage.

Defeated But Not Conquered

IF there had been any doubt as to the future policy of the advocates of large river and harbor appropriations, it is dispelled by the statement made early this week by Representative Sparkman, chairman of the rivers and harbors committee of the House of Representatives. It shows that the pork-barrel men were defeated but not conquered. They are planning to pass a "comprehensive" measure at the short session of Congress which begins Dec. 7. The pork-barrel view of the apportionment of funds by executive officers of the Government is expressed as follows by Mr. Sparkman:

"Personally, I dislike the lump sum provision of the Senate bill and I dislike the theory upon which the amendment was enacted into law, for I believe that when we place the distribution of money as legislators in the hands of the administrative branch of the Government, we abdicate, for the time being, those functions with which Congress is clothed under the Constitution. As representatives of the several constituencies of the Union which clothed us with the power to represent them, it is my fixed opinion that Congress should say in unequivocal language just how much money should be spent and for what definite purposes."

It is not difficult to discern in this statement the politician's attitude or the desire to get something for his district. With still another part of the statement given out by Mr. Sparkman to the press right-thinking men will disagree. "With the information at hand," he says, "or easily obtainable for intelligent action, we [members of Congress] are as capable of exercising the function of distributors as the army engineers, and I yield to none in my admiration for that splendid arm of the military establishment." While it is true that men who will carefully weigh the report of the army engineers are in a position to decide as to the relative needs for improvement of various waterways there is another factor to be considered. Congressmen are not disinterested parties and the temptation to trade is ever present. The army engineers are disinterested and they can be relied upon for a distribution entirely unaffected by political considerations. This phase of the subject Mr. Sparkman naturally wishes to ignore. He has an explanation for his position in that he appends to the sentence last quoted the clause, "But the responsibility rests with us and we ought not to shirk it." The Engineering Record feels sure that the country at large will gladly allow the representatives to "shirk" their duty whenever they are willing to place the distribution of funds in the hands of an executive branch so competent as the Corps of Engineers. It is to be hoped that the conscience of the House is sufficiently elastic, too, to allow it to shirk its duty in this respect with reference to river and harbor construction and public buildings. Then, to be consistent, it should revise its dictum regarding the abolition of executive distribution of funds in the Reclamation Service. It has recently passed a resolution placing that service in the pork-barrel class and imposing on Congress the task of specifying the projects on which sums are to be expended, thus upsetting the rule of departmental distribution which has been in effect since the establishment of the reclamation work.

Development Outlook in the Pacific Northwest

IT is quite well known that Western Canada has suffered a decided setback in its marvelous rate of development. This was foreseen by those conversant with conditions, and probably there will be a number of peaks and correspondingly deep depressions before stable conditions are assured. Coming at a time of stringency it might have been expected that the war would play great havoc with financial interests. It is surprising to note, therefore, that there has been no great change for the worse even though there has been some additional curtailment. The withdrawal of European support must, of course, be reckoned with in considering the near future.

A case typical of the present condition of Canadian investments dependent on European support is that of the British Columbia Electric Railway Company. With a capital outlay of about $40,000,000, this corporation finds the curve of its earnings to have dropped off steadily since the summer of 1913. This is not conducive to further investment, whether times be good or bad, particularly from sources not in close touch with the field. At such a time retrenchment is necessary, and the struggling company may have to "pay its own way" for a while or suffer the consequences of non-support. On the other hand, no one possessed of first hand information doubts that ultimately there will be a far greater development than now in the Pacific Northwest, both north and south of the international line, and that when that time comes permanent returns on well-planned investments can be depended upon.

One of the greatest factors in assuring the ultimate success of many western ventures is the continued and undaunted faith, common among Western people generally, that the resources will be developed in due time; and this faith is usually backed up by action that proves its sincerity. An instance of this is the recognition of an immediate need of facilities for handling Canadian grain at Pacific tidewater. A few days ago, in the face of the present crisis, Ottawa announced that plans would be very soon completed for a 1,500,000-bu. grain elevator at Vancouver, and that tenders would be promptly invited.

Even in the states of the Pacific Northwest there has been for some time a general tendency to postpone plans for all new construction or extensions not absolutely necessary, but to continue with work which is now under way.

The three transcontinental railroads of Canada have of late been spending far more money in the West than the railroads south of the international line, but this is probably explained by the fact that the Canadian government usually guarantees the cost of construction, and the funds are arranged for well in advance. Besides, two Canadian roads are just completing transcontinental lines, and to finish this work on time resources have been conserved.

It is worth noting, too, that some of the projects now under way in the Pacific Northwest are of unusual interest. The Rogers Pass tunnel, the New Westminster harbor work, the Victoria water supply system and the Seattle port works are of special importance. These activities are proceeding, indicating that even with the war stringency reinforcing the natural depression the Pacific Northwest is able to take good care of itself.

Ottawa's Waterworks Muddle

WITH its "off agin, on agin" policy of approving and disapproving plans for a new water supply, the city of Ottawa stands forth as the "Finnegan" of the waterworks field. When, after years of controversy, the plan of treating Ottawa River water by mechanical filtration was approved recently by popular vote, it was thought that the last obstacle in the way of actual construction had been removed, but this assumption was premature, for the Provincial Board of Health, as already announced in the Engineering Record, has refused to approve the plans and specifications prepared by Hazen & Whipple, of New York, and indorsed by George W. Fuller and J. Waldo Smith.

This news is discouraging enough, but it is nothing short of startling when its bearing on legislation passed last winter is considered. That legislation provided that, in the event of the disapproval of the Ottawa River plan by the Provincial Board of Health, the city of Ottawa would be compelled to construct the necessary works for the Thirty-One-Mile Lake scheme proposed by the English engineers, Sir Alexander Binnie and Dr. A. C. Houston. In the event of the city's refusal to construct the Thirty-One-Mile Lake project, the Provincial Board of Health was empowered to proceed with the construction, assuming for the purpose all of the powers of the city of Ottawa. By the terms of the act the city is prohibited from appealing to the courts for an injunction to stop the Provincial board in its effort to construct the Thirty-One-Mile Lake supply. The audacity of this mandate is apparent when it is realized that an excellent filtered supply of 35,000,000 gal. daily can be obtained from the Ottawa River for a cost of $2,000,000, while the Thirty-One-Mile Lake scheme, providing for a daily supply of only 25,000,000 gal., will run to $8,000,000. The constitutionality of such an act is open to question and the city undoubtedly will use every means in its power to combat it before submitting to what amounts to an extortion of about $6,000,000.

It is highly instructive to examine into the reasons of the Provincial board's disapproval of the Ottawa River project. They are, in their essence, that the Ottawa River is polluted and that provision is made in the plans for the use of hypochlorite of lime as an after-treatment, if this should prove necessary. As to pollution, the Ottawa River, in its raw state, contains generally something like 200 bacteria per cubic centimeter, and is comparable from the sanitary standpoint, according to the word of George W. Fuller, to Croton Water, which the people of New York drink unfiltered. It must be remembered, however, that the proposal was not to use Ottawa River water in its raw state, but to raise it to a high degree of purity by mechanical filtration. With respect to the use of hypochlorite, the board has distorted Allen Hazen's words, making it appear that the chlorinating treatment is one of the vital elements of the plan, instead of merely a precautionary measure. Mr. Hazen has since stated specifically that a good water can be produced without sterilization. The most ludicrous part of the whole affair is that the Provincial board, two years ago, approved practically the same plan for filtered Ottawa River water that it now feels called upon to reject.

From the whole complicated situation a clear moral can be drawn. As long as boards with no engineering representatives are vested with the power of passing upon the technical details of engineering works just so long will there be trouble. It is stated on good authority that when the plans for the Ottawa River filters were being explained to the members of the board, one of the questions asked was "Is there any sand in these filters?" Little more need be said.

Use of Pulverized Coal

IN the October "Journal" of the American Society of Mechanical Engineers is printed a full report of the symposium on pulverized fuel, which occupied an entire session at the Spring meeting of the society. Engineers interested in combustion efficiency will find the papers of Prof. Carpenter and Messrs. Low, Dalton and Quigley highly suggestive as to the development of the use of pulverized coal in the cement industry, in steam making and in industrial applications. Moreover, the amount of condensed information bearing upon essentials in the use of pulverized fuel which the discussion of these papers contains is exceptional.

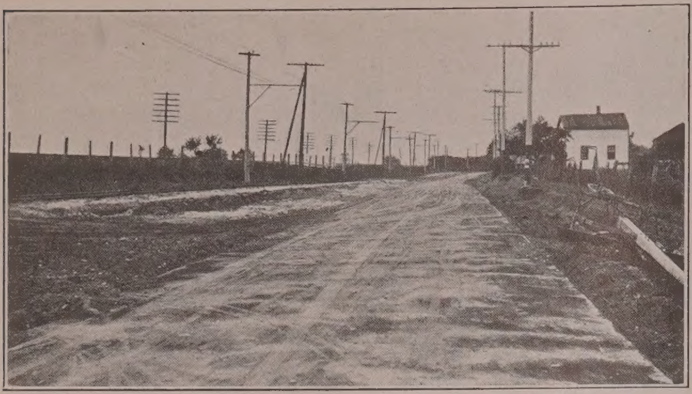
Powdered fuel is most successful in the cement kiln, in the reverberatory furnace, and in furnaces for heating billets and drop-forgings. Even should the difficulties of providing sufficient combustion space and of maintaining combustion be solved, there is little chance for powdered coal coming into general use with water-tube boilers. The cost of grinding eats up any possible small advantage in economy which might be realized over mechanical-stoker operation. There appears to be a field of usefulness, however, in connection with horizontal return tubular boilers. This is especially worthy of trial in connection with the handling of short and severe peak loads.

Coal running as high as 8 per cent of ash, with 35 to 40 per cent volatile content and 50 to 60 per cent of fixed carbon, is giving good results when pulverized, though the cost of grinding may easily total 30 or 40 cents per ton. The fundamental point in burning powdered coal successfully is to consume it while in suspension, and for that purpose the form of furnace used in the Portland cement industry is specially favorable. Losses in the flues of the rotary kiln have been cut practically in half by pre-heating the air and utilizing the exhaust gases.

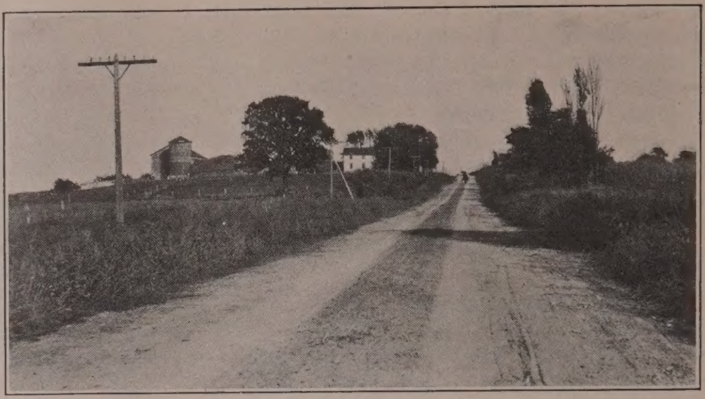
General agreement exists as to the absolute necessity of drying the coal to a maximum of about 1 per cent moisture in order to facilitate the distribution of the dust by the air blast, and it is also conceded that great care is necessary to prevent the formation of explosive mixtures of coal and air through inadequate control of the storage and flow of this highly combustible material. The design and operation of plants equipped with pulverized coal installations instead of decentralized oil heating for various pieces of equipment is decidedly interesting. Coal grinding mills, dryers, fuel transmission and distribution lines, special blowers with electric drive and automatic control have all been developed to a high degree to insure efficient operation. Such developments illustrate the refinements of industrial engineering and the susceptibility of auxiliary services to specialization.

The decision to use this class of fuel for a given case is largely a problem of comparison, once the availability of the material is demonstrated. A closely conducted test on two furnaces burning run-of-mine coal hand-fired in the one case and pulverized slack in the other gave a total cost of $1.45 per ton of output in the former and $1.05 in the latter, and indicated a saving in labor with pulverized fuel of $11.55 per 24-hour day. The uniformity of heating and excellent control obtained are likely to lead to the wider use of this fuel in forging and related applications.

The elimination and disposal of ash and slag are still serious problems in many cases, and while the practicability of utilizing powdered fuel seems well established from the engineering standpoint, nothing short of an extended estimate of total costs, including the fixed charges on the pulverizing plant and other equipment, should be relied upon to guide one toward a decision with respect to the employment of this material in unaccustomed fields.



CONCRETE STRIPPED OF PROTECTING EARTH BY GRADER



LIMESTONE ROAD BOUND WITH CLAY-BEARING GRAVEL

Country Roads in Southeastern Wisconsin

Innovations in State Aid Roads Include Clay-Bound Macadam, High Earth Shoulders on Narrow Roads, and Increased Thickness of Concrete

WITH the exception of the roads of Milwaukee County and a few trunk lines like the Lake Shore Drive the kind of country road in southeastern Wisconsin depends on the geology of the section. In the southern tier of counties and in those near the lake the black soil of Illinois prevails. Through these counties the regulation macadam roads are the rule. Farther north and west, where the glacial drift is composed more largely of gravel, gravel and crushed stone bound with clay or with a fine gravel which contains a large amount of clay have been used. This latter section has many natural roads which would be considered improved in other parts of the country. However, this is a rich dairy country and the land is under intense cultivation, so that the farmer realizes the necessity of getting his products to the market at all times of the year, and this can only be done over comparatively hard roads. Previous to the placing of all the road work on trunk lines under the State Highway Commission, road taxes had been worked out in a large measure by hauling stone onto the roads in a more or less desultory manner. The loads were dumped and sometimes not even spread. In very few cases have road rollers been used; the traffic has done most of the compacting. Gradually, with the numerous examples of State aid roads, the local officials are beginning to see that the old method was expensive and there is a better and more permanent construction at little or no advance in cost.

While there are several standards, the one most used is to grade the highway to a 32-ft. width between ditches and a 20-ft. width on top, and then to roll it thoroughly to a flat surface preparatory to cutting the subgrade, which is a 9-ft. trench, 7 in. deep at sides, thrown out by a road grader. No cut is made at the center so that when rolled the center is compacted to give a 5-in. crown. The excavated material is left on the sides to insure good shoulders. Two courses 4 in. deep, having 2 to 3½-in. and ½ to 2-in. stone respectively, are rolled and the road constructed in the same manner as ordinary macadam is built.

Where screenings and limestone are not available crushed gravel and field stone have been bound with a binding gravel of which two pits have been discovered in this section of the state. The comparatively fine gravel is overlaid with about 2 ft. of clay which has filtered down into the gravel. This is spread as a dressing in the same way as limestone screenings would be used. An example of this type of road is a 2-mi. stretch of Wilmot Road, 9 ft. wide, near Pleasant Prairie.

CLAY-BOUND MACADAM

Not unlike the Wilmot Road is the clay-macadam road, 8200 ft. long, on the extension of Twelfth Street, 1½ mi. from Racine on the Burlington Road. A granular clay was found in one of the excavations for a side road, which, when dry, breaks up into small cubes. This clay was applied in a thin coating to the bottom course, using a New Idea manure spreader so that when rolled the stones just began to show through. A second course of stone was spread and rolled. Then a very light dressing of the clay was applied and screenings or torpedo sand placed on top of the clay to keep the clay from sticking to the roller. Up to this stage in the construction no water was used on the road, but after rolling to an even grade a heavy flushing was applied from sprinklers and then a final rolling was given, sand or screenings being spread meanwhile whenever necessary to prevent sticking.

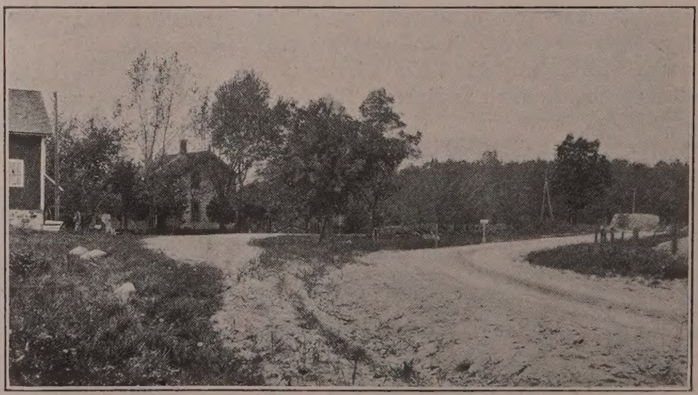
As an experiment an 1800-ft. section of road bound in this way was built early in the season near Big Bend, Waukesha County. This has gone through the past season in a satisfactory manner, although this summer has been exceedingly dry and in consequence hard on macadam roads.

MAINTENANCE OF MACADAM

After a gravel road is opened to traffic it is followed up at intervals with a grader and roller to keep it shaped up and to prevent ruts in the wheel track and undue raveling. Occasionally too much crown has been obtained. This is the fault of many of the roads not built under State supervision where material is simply hauled onto old traveled roads and traffic allowed to do the compacting.

It is now the idea of the highway commission to have all new macadam roads oiled the second year with ½ gal. of oil containing 80 per cent of asphalt. Holes are first repaired and the road is reshaped if necessary. The method is to oil a strip about 4 ft. wide in the center with about

ELEVATED SHOULDERS ALONG NARROW CONCRETE ROAD



LENGTHENED RADIUS REMOVES ROAD FROM DOORYARD

¼ gal. per square yard. Then a second application is put on to widen this strip to 10 ft. Thus the wearing surface gets somewhat more than ½ gal. per square yard. Sand or dustless screenings are thrown on to absorb the surplus bitumen.

ADJUSTING ALIGNMENT

While many of the roads follow township lines others are simply old turnpikes connecting the larger cities. On these some relocation has been carried out. Usually the engineers effect an exchange of property, but in some cases it becomes necessary to acquire a new right-of-way by condemnation proceedings.

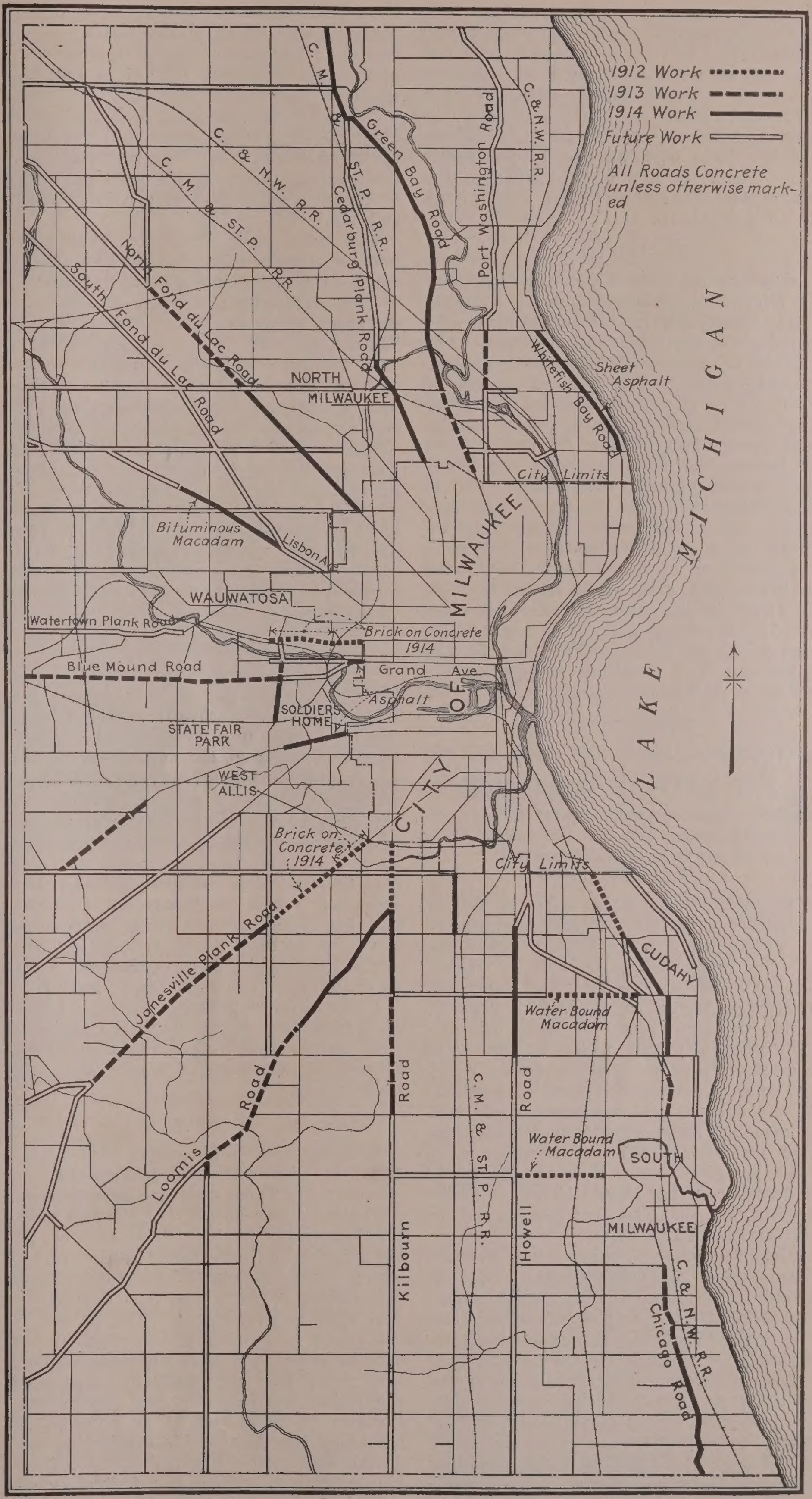
A change in alignment shown herewith on a road 1½ mi. from Waterford on the Waterford-Milwaukee Road, was made by lengthening the radius of a sharp curve. This was done at no expense to the county for land, as it threw the road out of a farmer's front yard, and happily he owns the property on both sides of the road.

In another case a change in the Green Bay concrete road, 4½ mi. from Milwaukee, involved a small yardage of excavation but eliminated a sharp and dangerous detour around a hill.

Over a marsh near Burlington the old road had been built very near one property line. It was moved toward the center 8 ft. only, to take advantage of the old compacted stone road which became the shoulder of the new one.

MILWAUKEE COUNTY CONCRETE ROADS

At the end of this season Milwaukee County will have 61 mi. of hard roads comprising 50 mi. of concrete, 1½ mi. of brick and 3½ mi. of asphalt on extensions of the Lake Shore Drive and other boulevards outside of the city limits. The remainder is bituminous and water-bound macadam. Three concrete roads are now completed to the county limits, and within two years it is planned to have at least five more. An inspection of ten concrete roads in Milwaukee County by a representative of the Engineering Record early in October, indicated that they are in good condition. Recently they have been gone over by the tar gang, filling the cracks and small holes. These roads have all been constructed within the last three years and a maintenance system has now been started so that every road will receive attention the second year after its construction. The average cost per mile of tarring an 18-ft. concrete road is $18. The first work in the county, the Janesville and the Watertown Plankroads, which were put down in 1912 with ungraded and unwashed pit-run gravel have worn uneven, and on top of the concrete there has been laid recently the regulation brick pavement.



COMPLETED AND PROSPECTIVE STATE HIGHWAYS IN MILWAUKEE COUNTY

INNOVATIONS IN 1914

Innovations in concrete road construction in Milwaukee County and in other sections of Wisconsin are as follows: Formerly it was a practice to chamfer the edges of the concrete by the use of a spade. This has been done away with inasmuch as at least a 6-in. width of road was lost thereby. The present practice is to round off the edge with a 1-in. radius tool. High earth shoulders are maintained particularly on narrow roads until the latter part of the season. While this causes a certain amount of dust and dirt to wash onto the road from the rains, it is considered much better from the traffic standpoint, as it results in a compacted shoulder. Steel joints of both the Baker and Truscon type have been used at 50-ft. instead of 33-ft. intervals on all roads put in this year. The thickness of the road has now been increased from 5½ to 6 in. at the sides and at the center from 7 to 8 in. Mixtures are now 1:2:3½ instead of 1:2:4. Most all work in 1914 in Milwaukee County was done by contract, the county renting its equipment to the various contractors. Prices at which these contracts were let were not materially above those which it cost the county in the two previous years to do the work by force account.

In the way of maintenance the city of

Port Washington is experimenting with patching concrete roads by cement and sand, 1 to 1 mix. The holes are scrubbed and cleaned after picking out all the loose material. The road is barricaded for three days and patches are covered with earth kept wet for at least seven days. These patches have been applied to pavements three years old and repairs made in the early part of this season are showing up in good condition.

ORGANIZATION

Organization under which State aid roads in Wisconsin are built comprises five non-paid State highway commissioners who appoint the State highway engineer. The boards of county commissioners are required to select a continuous system of roads which may be constructed jointly by the town, county and State, or the county may assume two-thirds of the cost and the State one-third. Improvements are made by a county highway commissioner and in accordance with his plans and specifications. No money comes to the counties until the work has been approved by a representative of the state engineer. All maintenance is assumed by the county. A. R. Hirst is the state highway engineer. W. M. DeBerard is division engineer in charge of the southeastern part of the State and H. J. Kuelling is highway engineer of Milwaukee County.

Proposed Bill for Licensing Pennsylvania Engineers

Engineers' Commission, Appointed by Governor, Submits Draft of Tentative Legislation and Invites Discussion of Measure at Public Hearings

TO facilitate discussion as to whether or not it is desirable to license engineers in Pennsylvania a commission consisting of John Price Jackson, Samuel A. Taylor, George S. Webster, F. Herbert Snow and J. Murray Africa, has prepared a draft of a bill, the main points of which are embodied in the digest which follows. The measure is based on the bill drawn up by the joint committee composed of members of the five national engineering societies. It was not recommended by the commission for passage but was advanced as a basis for discussion. Hearings were held in Pittsburgh Oct. 15 and 16 and in Philadelphia Oct. 19. The final hearing will be in Harrisburg Oct. 28.

The bill applies to persons who practise "professional engineering" and does not include contractors or construction superintendents in the employ of contractors. The term "professional engineering" includes every branch of engineering and surveying except military engineering, and by its terms no person shall practise professional engineering after June 30, 1915, unless he is registered. The bill would establish a State board of nine examining engineers, to be appointed by the Governor, each member to serve 6 yr. except those first appointed on the board. Of the first nine members, three would serve 2 yr., three, 4 yr., and the remaining three, 6 yr.

QUALIFICATIONS FOR EXAMINERS

Each member of the board shall: (1) Be a professional engineer of at least 10 yr. active experience. (2) Be of recognized good standing and repute in his profession. (3) Have the qualifications demanded of the highest grade membership in the American Society of Civil Engineers, or the American Institute of Electrical Engineers, or the American Institute of Mining Engineers. (4) Be at least 35 yr. of age. (5) Have been a resident of Pennsylvania during at least 5 yr. immediately preceding his appointment. (6) Be a registered professional engineer. (This shall not apply in the case of those first appointed under this act.)

The members of the board shall serve without compensation, but shall be allowed expenses actually and necessarily incurred in the performance of their duties. The secretary shall not be a member of the board. He shall possess the qualifications of a member, and shall receive an annual compensation of $3,600. The board shall hold at least six stated meetings annually in Harrisburg. At any stated meeting five members shall constitute a quorum. The board shall from time to time cause to be printed and furnish free of charge on request a complete list of the persons registered under this act to the date of such list, with the respective dates of registration and certificate numbers. The records of the board shall be at all reasonable times open to public inspection.

EXAMINATIONS

No person shall be examined for registration until he shall have paid the board a fee of $5 and shall have shown in writing and verified by affidavit that he is more than 25 yr. of age; is of good reputation, and has been engaged upon engineering work for at least 6 yr., and during that time has had charge of engineering work as principal or assistant for at least 1 yr. In lieu of this requirement the applicant may show that he is a graduate of an engineering school of recognized standing, and has been engaged upon engineering work for at least 4 yr. and during that period has had charge of engineering work, as principal or assistant, for at least 1 yr.

If the results of such examination shall be satisfactory to the board the applicant shall be registered as a professional engineer. A certificate of registration shall be issued to him.

REGISTRATION

Only the following persons shall be entitled to registration as professional engineers: (1) Those who have passed the examination of the board. (2) Persons registered in other states which require the registration of professional engineers and which have standards of qualifications satisfactory to the board. (3) Any person who shall before July 1, 1916, submit to the board in writing and verified by the oath or affirmation of the person, satisfactory proof that the applicant is of good reputation and has practised professional engineering for at least 10 yr. immediately preceding the date of his application and during that period has had charge of engineering work, either as principal or assistant, for at least 2 yr. No person shall be registered until a registration fee of $10 shall have been paid. The board may revoke the certificate of registration.

After June 30, 1916, every map or plan required by law or by contract to be certified or approved by a professional engineer shall be certified only by a registered professional engineer and shall bear the date and number of the certificate of registration of such professional engineer.

It shall be unlawful for any person not a registered professional engineer to practise professional engineering; hold himself out, by advertisement, or orally, or in writing, or otherwise, as a professional engineer; assume or use in any manner whatever any title or designation tending to convey the impression that he is a professional engineer; obtain by fraud or deceit registration as a professional engineer; have in his possession for any purpose, without the consent of the owner, a certificate of registration.

Any person shall be guilty of a misdemeanor who shall violate any of the provisions of this act. Upon conviction thereof he shall be sentenced to pay a fine not exceeding $1000 or undergo an imprisonment not exceeding 1 yr., or both.

SCOPE OF ACT

The provisions of this act shall not apply: (1) To any professional engineer while working for the government of the United States. (2) To any professional engineer employed as an assistant to a registered professional engineer. (3) To a professional engineer coming from another State, territory or county and temporarily practising his profession in this State. The board shall by rule or regulation fix limits for such temporary practice. (4) To a professional engineer coming from another State, territory or county who has applied for examination and registration, pending his registration. The board shall by rule or regulation fix limits for such practice.

Tests of Vanadium Steel Rails

Conclusions Drawn by Producers of Vanadium Steel from Their Investigations—Proposed Chemical Specification

BELIEVING that the use of vanadium in rail steel would greatly reduce rail failures and at the same time greatly increase the wearing quality of the rails, the American Vanadium Company, Pittsburgh, has had several heats of basic open-hearth vanadium steel rolled into rails for test purposes. The details of the tests are given in a twenty-four page pamphlet issued by the company. From the investigations the company draws the following conclusions:

Manufacture.—The manufacture of rails from vanadium steel does not require any change in the usual rail-mill practice. The steel rolls clean and shows no tendency to crack or tear. No change is necessary in the gages, as vanadium steel takes the same standard gage as simple carbon steel. Nothing developed in the melting, casting, heating or rolling of these heats of vanadium steel to indicate that the mill output will in any way be reduced. The percentage of yield of rails from the ingots is equal to or even greater than for simple carbon steel rails, and the evidence is that there will be less scrap from cracking or tearing in the rolls, and that the percentage of second quality rails will be less.

Drop Tests.—The vanadium steel rails met all the requirements specified for ductility and deflection and are stiffer or more resilient than the 100-lb. carbon steel rails of the same section. They deflected about the same amount from an 18-ft. blow as the carbon steel rails did from a 15-ft. blow.

Tensile Tests.—The vanadium steel rails show an elastic limit averaging more than 40 per cent higher than for the simple carbon steel rails, although the latter had 50 per cent higher carbon content. The ratio of elastic limit to breaking strength is 70 per cent or more for the vanadium steel rails as compared with about 57 per cent for the carbon steel rails. The ductility or toughness also shows higher.

Alternating Impact Tests.—Vanadium steel of the high elastic limit shown by the test rails has great endurance under repeated stresses, and is free from brittleness.

Bend Tests.—Although the vanadium steel rails are very much harder than the simple carbon steel rails, the bend tests are equally good.

Hardness Tests.—The vanadium steel rails show great uniformity of hardness throughout the entire section, and are from 10 to 35 per cent harder than the carbon steel rails with 50 per cent more carbon. This superior hardness, combined with the high elastic limit and the great toughness of the vanadium steel rails, indicates a great increase in wear-resisting qualities.

Wear Tests.—Comparative tests show a great increase in wear resisting qualities for the vanadium over the simple carbon steel rails.

Chemical Uniformity (Segregation).—The vanadium steel rails show no segregation, the variations in analysis noted being within the allowable limits of analytical error. The standard high carbon steel rails usually show segregation and in the case of the "A" rails the segregation is frequently very marked.

Homogeneity and Density. — Sections from the vanadium steel rails etched with boiling dilute sulphuric acid show a remarkably dense, uniform structure, free from piping, slag and other defects. The contrast in this respect with the etched sections of the carbon steel rails is very striking. The carbon rails were selected at random by the makers.

From the results of the tests the company recommends the chemical specification given in the table. The company asserts that this specification will give rails with from 30 to 50 per cent higher elastic limit, combined with greater toughness and hardness than simple carbon steel rails with from 0.62 to 0.75 per cent carbon content; that the vanadium steel rails will show even greater superiority in comparison with lower carbon steel rails of from 0.45 to 0.60 per cent carbon, and that the relatively low percentage of carbon recommended, together with the great freedom from segregation of vanadium steel, should result in the practical elimination of the danger of failure from internal fissures or silvery oval spots.

CHEMICAL SPECIFICATION FOR VANADIUM STEEL RAILS

Ingredient	Per cent
Carbon	0.45 to 0.60
Manganese	1.00 to 1.25
Silicon	More than 0.10
Phosphorus	Not more than 0.05
Sulphur	Not more than 0.05
Vanadium	4 lb. added per gross ton

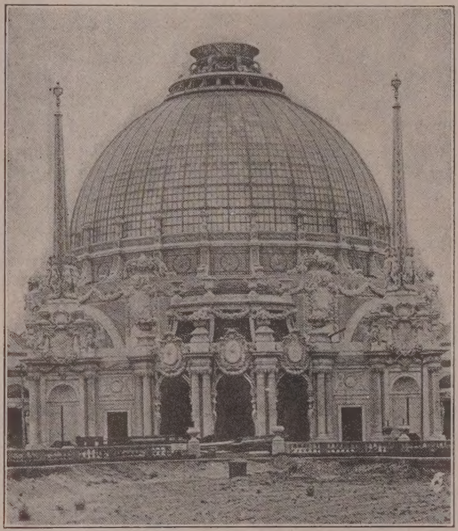
TESTS ON THERMIT WELDED pipes from 1 to 1¼ in. in diameter, made by Prof. Frederick L. Pryor of the Stevens Institute of Technology, have shown that the tensile strength at the weld is practically the same as for straight pipes without joints and considerably higher than the strength of standard threaded sleeve couplings. Subjected to bursting tests all specimens ruptured in the seam of the pipe.

Design of 152-Foot Steel-Framed Dome

Analytical Methods Used for Hemispherical Superstructure of Exposition Palace of Horticulture at San Francisco—Part I

By A. W. EARL and THOMAS F. CHACE
Assistant Engineers, Panama-Pacific International Exposition

WITH a diameter of 152 ft. the hemispherical steel-framed dome of the Palace of Horticulture for the Panama-Pacific International Exposition at San Francisco takes rank among the largest structures of this type ever built, exceeding in size the 142-ft. dome of the Pantheon at Rome, and the 135½-ft. dome of the U. S. Capitol at Washington. The only larger dome on record is the one for the Horticulture Building at the Chicago exposition, which had a diameter of 185 ft. The Palace of Horticulture is rectangular in plan, approximately 660 ft. long by 300 ft. wide and covers an area of 4½ acres. The eastern or main portion, which is square in plan, forms the base for the imposing glass-covered dome, which rests upon a cylinder 25 ft. in height. The extreme height from the ground to the top is 186 ft.


DOME OF PALACE OF HORTICULTURE

STRUCTURAL FRAME

The type of framing is similar to that first used by the noted German engineer, Schwedler. It consists of twenty-four latticed ribs 36 in. in depth, which frame into a spider at the top, and are connected by eleven horizontal latticed rings. The outer chord of the rib is composed of two 4 x 4 x 5/16-in. angles, while the inner chord is built of two 3 x 3 x 5/16-in. angles, the two being connected by 2½ x 2 x ¼-in. single-angle lacing. The lower portions of the ribs are straight, forming the sides of a vertical cylinder; the top of this cylinder is the spring line of the dome. The bases of the ribs are supported on plate girders and trusses, the elevation of which is 65 ft. above the floor level.

The spider at the apex of the dome is 6 ft. in diameter, 36 in. deep and is reinforced by four diaphragms. The circular flanges are 4 x 4 x 5/16 in. and the web is 5/16 in. thick. The diaphragms are both alike and each is composed of four angles 3 x 3 x 5/16 in. with a 5/16-in. web plate.

The horizontal rings, with the exception of the one at the spring line, are 18 in. deep. This latter ring has the same depth as the ribs.

Intermediate between the main ribs and framing into the rings are 4-in. I-beam purlins. All panels are braced by two adjustable diagonal rods, varying in size from 9/16 in. square at the top to 1⅜ in. square at the bottom. Wooden purlins and the usual skylight bars complete the framework for the glass. The dome is supported on eight piers 65 ft. in height.

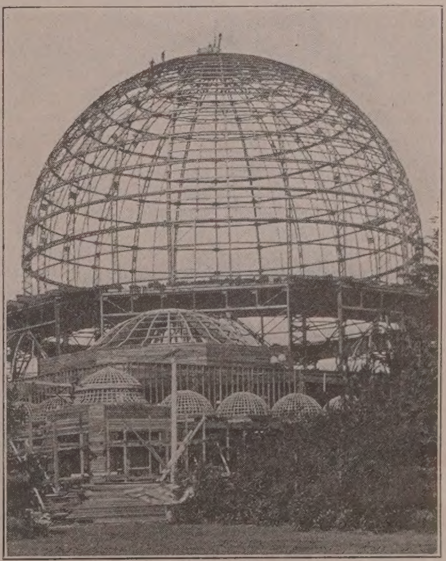
The details of the dome framing are shown in one of the drawings. Particular attention is called to the use of angle lacing bars in the ribs and rings instead of the usual lattice bars. While theoretically taking no primary stress, these angles are capable of transmitting much more shear than flat lacing bars of the same weight which, while effective for tension, are of a poor section to transmit compression.

DOME DESIGN

There are two methods commonly employed in the design of framed domes. The first, and perhaps the most common consists of treating any two diametrically opposite ribs as forming a three hinged arch, the hinges at the crown being replaced by a circular girder. In this method wind stresses are taken care of by considering the wind as a live load on one side of the dome and applied only in the plane of the two ribs forming the arch. Diagonal rods are usually provided in the panels of alternate bays to resist unequal loading and to give general stiffness to the structure.

The second method regards the ribs as members of a true dome, wherein all stresses are resisted by compression in the ribs and compression or tension in the horizontal rings. Wind and all other than uniform vertical loads are taken care of by placing diagonal rods in every panel of the dome.

By applying the second method to structures of this type more material is saved than might at first be supposed. In the present instance the dome was completely


STEEL FRAMING FOR DOME

designed by both methods—the second method resulting in a saving of one-third the steel called for by the first design in the portion of the structure above the plate girders. With the same number of ribs in both cases, the ribs in the first design were 72 in. deep with chords of two 6 x 6 x ½-in. angles with ⅜ x 14-in. cover plates, while the ribs as actually built are 36 in. deep with chords not exceeding two angles 4 x 4 x 5/16 in., with no cover plates.

The writers lay no claim to originality in the following mathematical discussion, but rather have applied formulæ and methods already developed in the design of similar structures.

RIB AND RING STRESSES

The rib and ring stresses were determined by the method outlined by E. Schmitt in the "Transactions" of the American Society of Civil Engineers (Vol. 52, 1904), and there is needed no further explanation than the load and stress summary and dead and live load diagrams shown in Figs. 1, 2 and 3.

The ribs and rings of the dome of the Horticulture Building at the World's Columbian Exposition at Chicago were taken as a basis for a preliminary estimate of the weights, and from this a tentative design was made. The dead load of the roof covering was estimated by direct computation. Using the sections obtained from these stresses, a final estimate of weight was made, the stresses recomputed, and the members modified as necessary.

DIAGONAL STRESSES

The problem presented in finding the diagonal stresses was slightly more intricate than that of the ribs and rings. Three methods were used, all based upon different assumptions. The first was as outlined in Hütte, the second somewhat similar to that given in Hazlehurst for stresses in a steel water tower, and the third like that followed in the article on a gas holder in "Engineering News."

The following is the Hütte method: Let Q_1, Q_2, Q_3, etc. (Fig. 4), represent the total dead plus live load per panel. Let P_1, P_2, P_3, etc., represent the total dead load per panel. Let A_1, A_2, A_3, etc., represent the angle between the ribs and the horizontal, and B_1, B_2, B_3, etc. (Fig. 5), the angle between the ribs and the diagonals. Let N_1, N_2, N_3 represent the diagonal stress. Then:

$$N_1 = (Q_1 - P_1)/2 \sin A_1 \cos B_1$$

$$N_2 = [Q_1 + Q_2 - (P_1 + P_2)]/2 \sin A_2 \cos B_2$$

$$N_3 = [Q_1 + Q_2 + Q_3 - (P_1 + P_2 + P_3)]/2 \sin A_3 \cos B_3$$

The angles A and B were scaled from a carefully constructed diagram and their values are recorded in Fig. 6. Further, it will be noted that the diagonals do not extend to the top of the dome, but discontinue at ring 3. Calling the diagonal between rings 3 and 4, N_1, and numbering the others consecutively toward the base of the dome, the resulting stresses were found to be:

$$N_1 = 1780/2 \sin 24° \cos 30½° = 2530$$

$$N_2 = 3250/2 \sin 31½° \cos 38° = 3960$$

$$N_3 = 5030/2 \sin 39½° \cos 45½° = 5630$$

$$N_4 = 6920/2 \sin 47½° \cos 50° = 7300$$

$$N_5 = 8960/2 \sin 55° \cos 53° = 9100$$

$$N_6 = 10830/2 \sin 62\,2/3° \cos 56½° = 11050$$

$$N_7 = 12430/2 \sin 70° \cos 59° = 12850$$

$$N_8 = 13680/2 \sin 78¼° \cos 60° = 14000$$

$$N_9 = 14450/2 \sin 85¾° \cos 62½° = 15700$$

With the exception of the 2 in the denominator, the above formula is the result of simple resolution of given forces in given directions and assumes that half of the dome lying on one side of the meridian through the center of the panel containing the diagonal in question is fully loaded while the other half of the dome carries no load at all. The 2 in the denominator is introduced on account of results obtained by Müller-Breslau and others from exact analyses which gave stresses about one-half as large as those given by the original Schwedler formula. The exact analysis of a dome by methods of least work, while presenting an interesting and instructive academic problem, is by far too laborious and complicated for commercial office uses since the first principle of design has been met when a structure has been designed which safely and economically serves the purpose for which it is intended. The method is thus seen to be largely empirical and its application requires experience and judgment in the selection of live loads. In this

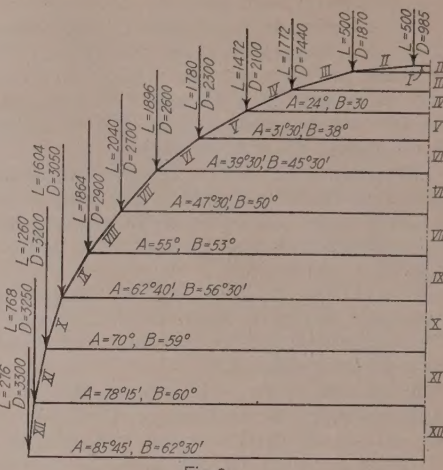
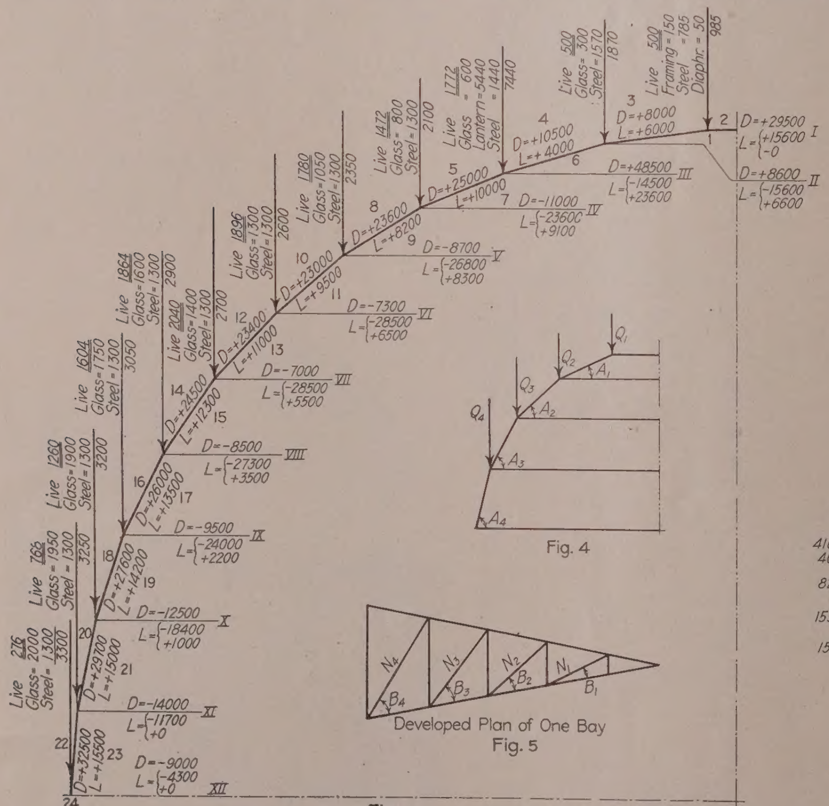


Fig. 6

FIG. 6.—LOAD DIAGRAM, HÜTTE METHOD



Live 276 Glass=2000 Steel=1300 3300
Live 768 Glass=1950 Steel=1300 3250
Live 1260 Glass=1900 Steel=1300 3200
Live 1604 Glass=1750 Steel=1300 3050
Live 1864 Glass=1600 Steel=1300 2900
Live 2040 Glass=1400 Steel=1300 2700
Live 1896 Glass=1300 Steel=1300 2600
Live 1780 Glass=1050 Steel=1300 2350
Live 1472 Glass=800 Steel=1300 2100
Live 1772 Glass=600 Lantern=5440 Steel=1440 7440
Live 500 Glass=300 Steel=1570 1870
Live 500 Framing=150 Steel=785 Diaphr.=50 985
D=+29500 L={+15600 -0 I
D=+8600 L={-15600 +6600 II
D=+8000 L=+6000
D=+10500 L=+4000
D=+48500 L={-14500 +23600 III
D=+25000 L=+10000
D=-11000 L={-23600 +9100 IV
D=+23600 L=+8200
D=-8700 L={-26800 +8300 V
D=+23000 L=+9500
D=-7300 L={-28500 +6500 VI
D=+23400 L=+11000
D=-7000 L={-28500 +5500 VII
D=+24500 L=+12300
D=-8500 L={-27300 +3500 VIII
D=+26000 L=+13500
D=-9500 L={-24000 +2200 IX
D=+27600 L=+14200
D=-12500 L={-18400 +1000 X
D=+29700 L=+15000
D=-14000 L={-11700 +0 XI
D=+32500 L=+15500
D=-9000 L={-4300 +0 XII
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Q1
Q2
Q3
Q4
A1
A2
A3
A4
N4
N3
N2
N1
B4
B3
B2
B1

Fig. 4

Developed Plan of One Bay
Fig. 5

Fig. 1

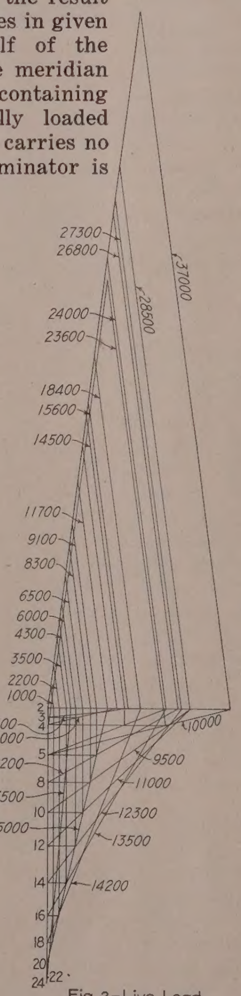


Fig. 2–Live Load

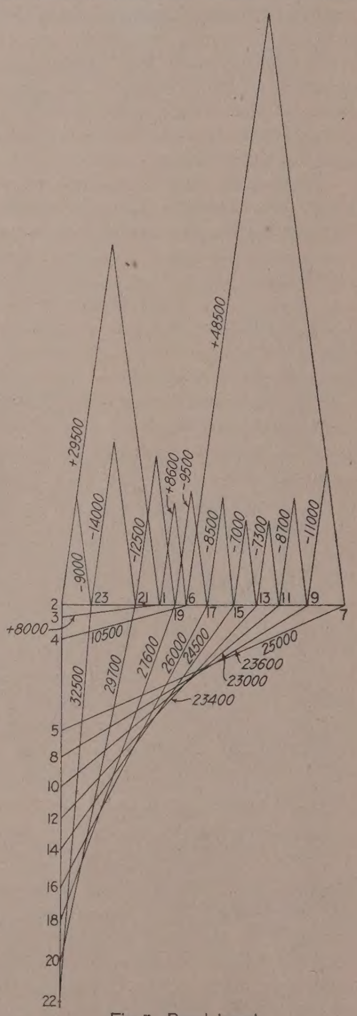
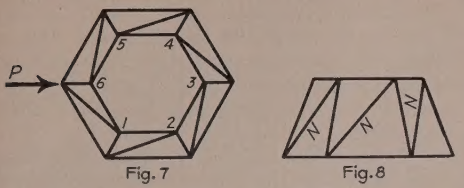


Fig. 3–Dead Load

FIGS. 1-5.—LOAD DIAGRAMS AND SUMMARY OF STRESSES BY SCHMITT METHOD (FIGS. 1-3), AND PANEL LOADING AND PLAN OF ONE BAY FOR HÜTTE METHOD (FIGS. 4 AND 5)



FIGS. 7 AND 8.—DIAGRAMS FOR HAZELHURST METHOD

instance a live load of 20 lb. per square foot of horizontal projection was taken.

HAZELHURST METHOD

On account of the empirical nature of the Hütte formula for stresses in the diagonals, it was deemed advisable to check them by some method based on wind pressure, which would be the most likely cause of stress in the diagonals of a glass covered dome of this character. To this end the method for the solution of the stresses in a water tower to be found in Hazelhurst's book on the subject, was adapted to the dome design.

The system may be briefly illustrated by reference to Figs. 7 and 8. Let Fig. 7 represent a section through any trussed pyramid with inclined posts and acted upon by wind. Let P = the total wind shear from all zones above. Let $p = P$ divided by the total number of ribs; in this case $p = P/6$. In other words, the shear is assumed to be equally divided among the ribs.

In addition to the forces p acting at each rib there will be a horizontal component of the ribs. This component is most easily found by first computing the uplift at every point, assuming all ribs on the windward side of the neutral axis to be in tension while those on the leeward side are in compression, and further assuming that the magnitude of the tension or compression varies directly as the distance from the neutral axis. Then, knowing this vertical component and the angle of inclination of the rib with the horizontal, the horizontal component of the rib stress may be computed. The resultant of this horizontal component of the rib stress and the force p at every rib is then found, and finally this resultant is projected onto the two ring members. When this is done it will be seen that there is still an unbalanced condition at the point. The diagonal furnishes the balancing component. The result of this method for the various diagonals was as follows: $N_1 = 1000$; $N_2 = 1700$; $N_3 = 2700$; $N_4 = 4000$; $N_5 = 6700$; $N_6 = 7100$; $N_7 = 10{,}000$; $N_8 = 13{,}000$; $N_9 = 14{,}500$.

THIRD METHOD

The third and final method of computing the diagonal stresses was adapted from the "Engineering News" article (Vol. 66, page 644). It may be seen from a study of the same that the bays most nearly parallel to the direction of the wind take the greatest diagonal stress, which in amount is equal to twice the average of all the bays. Thus referring again to Figs. 7 and 8, the horizontal component H, of the maximum diagonal stress in any zone is equal to the total wind shear, P, from all the zones above divided by one-half the number of panels; in Figs. 7 and 8 $H = P/3$. Having determined this horizontal component of the stress, it is a matter of simple resolution of forces to obtain the total stress in the rod. The preceding method was followed in the present analysis of the dome, using graphical diagrams which are not of sufficient importance to reproduce.

The accompanying table gives a summary of the results obtained by the three methods.

The results by the three methods are thus seen to check closely where the ribs of the dome approach the vertical, although they depart widely from each other where the ribs become more nearly horizontal. The rods in the dome are all designed for the maximum stress given in the table.

SUMMARY OF RESULTS OBTAINED BY THREE METHODS

	Stress		
Diagonal	Hütte	Hazlehurst	Eng. News
N_1	2,530	1,000	600
N_2	3,960	1,700	800
N_3	5,630	2,700	1,500
N_4	7,300	4,000	2,700
N_5	9,100	6,700	4,000
N_6	11,050	7,100	6,100
N_7	12,850	10,000	8,000
N_8	14,000	13,000	11,300
N_9	15,700	14,500	14,000
*N_{10}	.....	36,000	36,000

*Diagonal in cylindrical portion of dome below the spring line.

It has been pointed out above that the Hütte method for finding the stresses in the diagonals is largely empirical. The same criticism may be made of the other two methods, since in each of these the assumption is made that the wind shear is distributed equally among the ribs, an assumption whose truth depends largely upon the stiffness of the horizontal rings. The close agreement shown by the preceding table may not always be realized.

It is therefore obvious that in the design of a structure of this nature, a satisfactory design depends to a great extent on the judgment and experience of the designer, and while the methods here outlined are applicable to the general case of domes, no conclusion based upon this study of one dome should be applied to any other dome

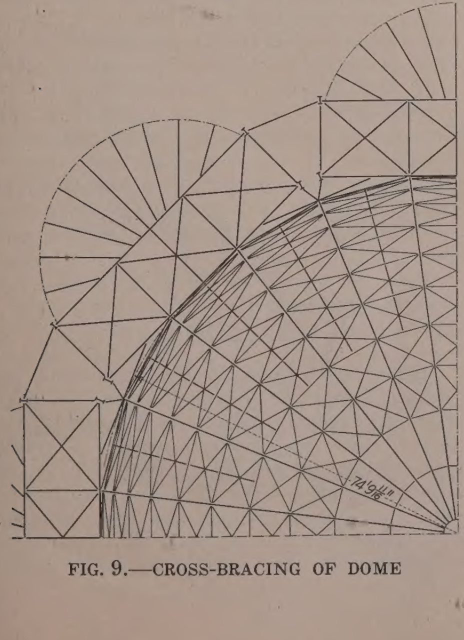


FIG. 9.—CROSS-BRACING OF DOME

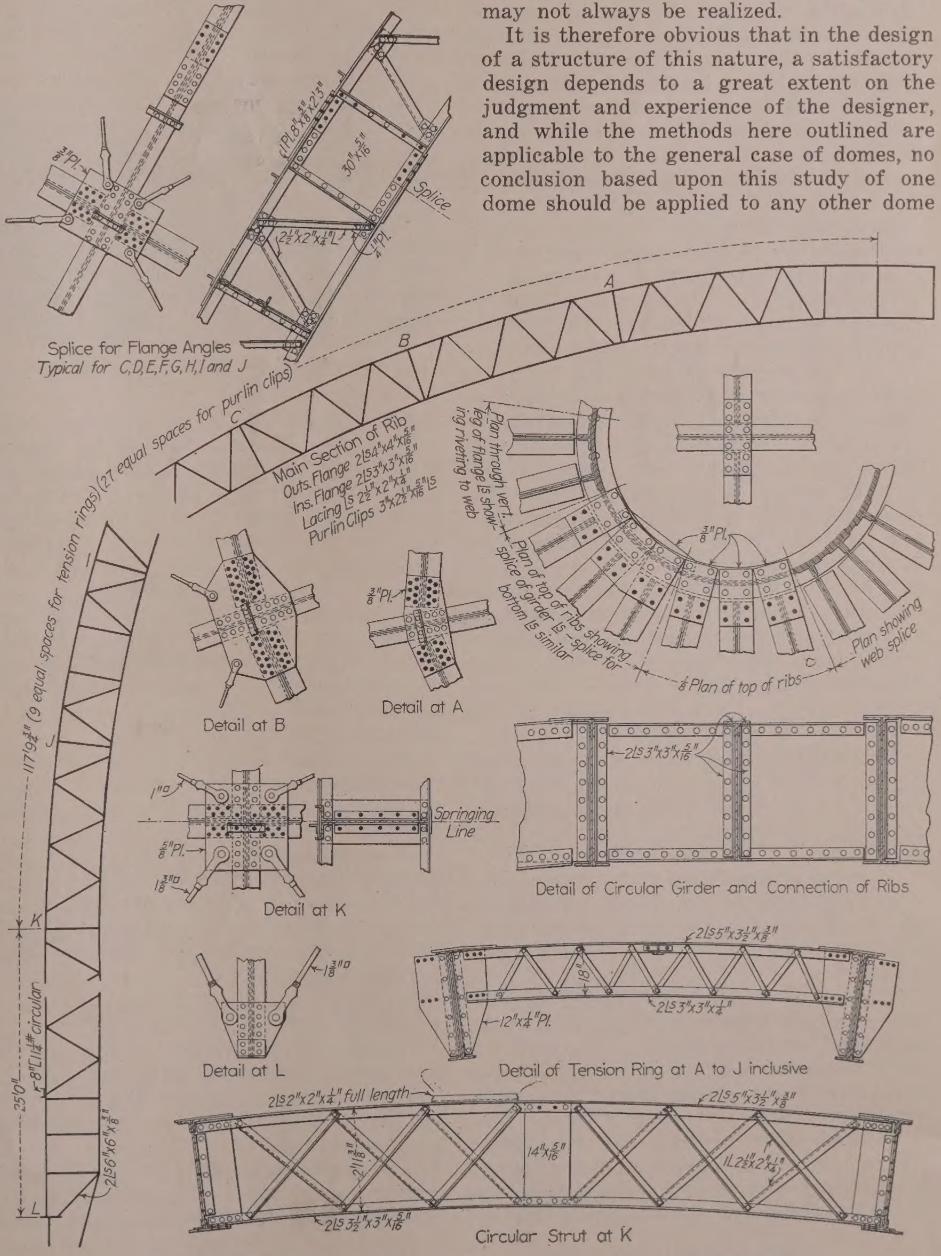

⅜"Pl.
1Pl. 8"x⅜"x2'3"
30"x5/16"
Splice
2½"x2"x¼"L
¼"Pl.
Splice for Flange Angles
Typical for C,D,E,F,G,H,I and J
A
B
C
(27 equal spaces for purlin clips)
Main Section of Rib
Outs. Flange 2Ls 4"x4"x5/16"
Ins. Flange 2Ls 3"x3"x5/16"
Lacing Ls 2½"x2"x¼"
Purlin Clips 3"x2½"x5/16" Ls
Plan through vert. leg of flange Ls showing riveting to web
Plan of top of ribs showing splice of girder Ls - splice for bottom Ls similar
⅜"Pl.
⅛ Plan of top of ribs
C
Plan showing web splice
I
J
117'9¾" (9 equal spaces for tension rings)
Detail at B
⅜"Pl.
Detail at A
1"□
⅝"Pl.
1⅜"□
Springing Line
Detail at K
2Ls 3"x3"x5/16"
Detail of Circular Girder and Connection of Ribs
K
8"[11¼# circular
25'0"
2Ls 6"x6"x⅜"
L
1⅜"□
Detail at L
2Ls 5"x3½"x⅜"
18"
2Ls 3"x3"x¼"
12"x¼"Pl.
Detail of Tension Ring at A to J inclusive
2Ls 2"x2"x¼", full length
2Ls 5"x3½"x⅜"
2'11⅜"
14"x5/16"
1L 2½"x2"x¼"
2Ls 3½"x3"x5/16"
Circular Strut at K

FIG. 10.—FRAMING PLAN OF DOME AND DETAILS OF MAIN RIBS

without careful consideration of the particular case.

TYPES OF MEMBERS

In the selection of members to resist the computed stresses careful consideration was given various types of ribs and rings. The trussed type was decided upon because of its stiffness and ability to resist the secondary stresses due to bending. This latter consideration is an important factor since the line of action of the stress between panel points in both ribs and rings is assumed to be a straight line while as a matter of fact the members are curved. Further, where there is a heavy lantern on the dome, as in the present case, there should be a stiff ring at the top to insure a uniform distribution of this load.

(To be concluded)

Latin-American Trade Committee Reports

Body Appointed by the Secretary of Commerce Recommends Methods of Procedure to American Manufacturers

THAT industries of the United States will be seriously injured by loss of Latin-American trade if the restriction of commercial credits is not remedied and that it is to be hoped banks will extend accommodations at least sufficient to assure maintenance of existing trade is one of the conclusions of the Latin-American Trade Committee appointed by the Secretary of Commerce, W. C. Redfield.

How dependence upon London banking saps American foreign selling power and how the sister republics are turning to the United States for funds to carry on industrial development are set forth in the committee's report which was issued Oct. 19 for the purpose of providing the public's intense interest with a businesslike analysis of present conditions and future prospects. That the greatest opportunity lies in systematic preparation for extension of trade when peace restores normal conditions rather than in hasty invasion of southern markets is another conclusion. The committee is headed by James A. Farrell, chairman of the National Foreign Trade Council and consists of representatives of manufacturing, commercial, transportation and financial elements engaged in, or affected by, foreign trade.

PRESENT CONDITIONS

Even before the war, the committee found, United States' exports fell off on account of the financial stringency in South America. Of present conditions the report says:

"Since August 1 of this year the countries in South America whose currency is not already on a gold basis have experienced a serious depreciation of their paper money.

"Collections throughout South America, therefore, are difficult, orders are falling off, and after our exporters have completed their contracts for this year, there seems less prospect for new business, unless steps are taken to relieve the situation."

"Before trade can resume its normal course," the report continues, "the exchange problem must be solved, either by the restoration of old, or by the establishment of new credit facilities."

The committee found that in contrast to the well balanced commerce of England and Germany, the Latin-American trade of the United States showed in the fiscal year of 1914 a balance of $187,012,514 against this country.

"Our exports to, and imports from, Latin-America are shipped direct," says the committee, "but (almost exclusively in South America and largely in Central American trade) they are paid for in sterling bills of exchange.

"We have been obliged to settle this adverse balance of trade by remitting to England either gold or goods to meet interest charges on the South American debt and to pay for goods purchased in Europe by the South American countries. . . .

"It has been increasingly the practice of European bankers to stipulate the use of European material in the projects which they financed. Latin-America is now turning to the United States for funds. This country is hardly in a position to undertake considerable investments at the present time, but industries with an already considerable trade at stake may well consider the necessity of protecting that trade by obtaining for their customers some relief from the present stringency. Such investments, if judiciously made, would yield an ultimate fair return and meanwhile provide a market for American materials which cannot now be sold.

"The question of creating a market for Latin-American securities in the United States, therefore, is highly important. The development of our trade with those countries is largely dependent on its satisfactory solution.

"Unless the restriction of commercial credits be remedied, however, we will not only be unable to extend our trade, but we will lose a considerable portion of that which we already have."

PARTIAL DEPENDENCE ON LONDON EXCHANGE

While the committee admits that trade with South America must partly depend upon London exchange so long as the republics owe heavily to Europe it urges that in the mutual interests of all the American republics new credit machinery be created to escape, partly at least, dependence on London. The committee adds:

"Whenever there is a great disturbance of the world's finances, American exporters and importers in South American trade are injured because of their dependence on London. This has happened four times in twenty-five years."

The committee considered the proposed establishment of a "co-operative exchange" or merchants' clearing house for Latin-American trade.

On account of the difficulty of obtaining co-operation, the necessity and difficulty of standardizing credits, the seasonal variations of shipments of South American produce and the expense the plan was pronounced impracticable.

PRAISE FOR GOVERNMENT EFFORTS

The committee praises the efforts of the government and particularly Secretary of Commerce Redfield for efforts to develop foreign trade and makes the following recommendations:

"The extension of credits might be facilitated and some relief afforded, pending the establishment of the Federal Reserve Banks, if, in addition to permitting national banks which have signified their intention to enter the Reserve Associations, to accept commercial paper, action be taken by the Federal Reserve Board to make immediately effective the rediscount provision of the new banking system thus assuring early establishment of a discount market.

"Your committee feels that merchants and manufacturers now contemplating an entry into the Latin-American field should be careful to avail themselves of the easily accessible information concerning these markets. The cost of maintaining individual representatives would probably be too great for many of them to bear themselves. It is therefore suggested that associations consisting of the smaller firms or corporations engaged in kindred lines of production might be formed, and that either one or more representatives should be sent to South America to look after the interests of such associations, thereby bringing the cost of representation within a reasonable limit.

"It has been suggested that American manufacturers should combine to send to South America trade exhibits, showing the various articles which they have for sale. Your committee, however, is not inclined to feel that such measures would be productive of any permanent results. It is suggested instead that manufacturers and dealers desiring to place their products in Latin-America, and who, for any reason, prefer not to send their own representatives there could establish connections with export houses already doing business in those countries and maintaining large branch offices in the principal South American cities fully equipped with efficient sales organizations or who have established connections, and in certain lines of goods—foodstuffs, notions, and miscellaneous articles—join in establishing what might be called for want of a better name an 'American Store,' in certain of the most important cities.

"Merchants and manufacturers should not attempt to install their own establishments in Latin-America unless they are prepared to meet initial losses and disappointments before realizing even moderate profits.

"Your committee begs to state its belief that the present disorganization of the trade of the United States with Latin-America may best be remedied and placed on a permanently satisfactory basis by

"First—The establishment of a dollar exchange, through the ultimate creation of a discount market and pending the establishment of a discount market, by the extension of adequate accommodation by banking institutions, and the establishment of reciprocal balances in the United States and in Latin-America for financing Latin-American trade.

"Second—Perfection of our selling machinery by furnishing additional support to commission houses familiar with Latin-American business; by forming associations of merchants and manufacturers to be jointly represented in Latin-America, and by obtaining information as to the possibilities of developing retail stores in large Latin-American cities."

DISASTROUS FIRES at the docks along the Seattle waterfront have led to an ordinance providing that all docks constructed hereafter shall be provided with fire walls spaced not further apart than 500 ft. on centers and fire stops not more than 100 ft. apart. These provisions are not required in structures fully equipped with automatic sprinklers.

Railroad-Yard Lighting at McKees Rocks

Lamps Mounted on Eight 100-Foot Towers Give Necessary Illumination at This Pittsburgh & Lake Erie Yard

A SOCIETY paper setting forth the importance and the peculiar problems of railroad-yard lighting was abstracted in the Engineering Record of April 4, page 388. A recent installation is that at the classification yard of the Pittsburgh & Lake Erie Railroad at McKees Rocks, near Pittsburgh. The yard contains about twenty tracks extending approximately half a mile.

Two rows of steel towers, one each side of the yard, carry the lights. The towers are 100 ft. high and 12 ft. square at the base. They are spaced about 400 ft. apart longitudinally, the two rows being about 225 ft. apart. On each tower is a Cooper Hewitt quartz lamp, suspended from a short mast arm extending out over a platform for the attendant, access to which is had by means of a ladder mounted on the side of the tower. A chain and cut-out, however, permit the attendant to lower the lamp to the ground without climbing the tower.

GENERAL VIEW OF YARD AND LIGHTING TOWERS AT McKEES ROCKS

The installation consists of eight units, the lamps being rated at 2400 candle power, with an energy consumption of 726 watts. Direct current at 220 volts is supplied from the company's power plant near by. As the quartz burners have a life of several thousand hours, and as the globes are at such a height as to be out of the smoke zone, the lights require little attention. It is said that the light completely floods the yard, the illumination being such that one can easily read a newspaper by it at night. It is also stated that there is an entire absence of shadows or glare.

The system was installed under the direction of D. P. Morrison, electrical engineer of the Pittsburgh & Lake Erie Railroad.

THE GREATEST IRON-ORE PRODUCER in the United States is Minnesota, by a wide margin, according to a bulletin issued by the U. S. Geological Survey. In 1913 the total marketed production in the country was 59,643,098 long tons, valued at $130,905,558, of which Minnesota contributed 36,603,331 tons, valued at $80,789,025. In 1912 Minnesota produced 34,249,813 tons, valued at $61,805,017.

Draining District 9, Mississippi County, Arkansas

Improvements Involving 14,000,000 Cubic Yards of Dredge Excavation to Prevent River Overflow and Provide Local Drainage

By L. L. HIDINGER

Assoc. M. Am. Soc. C. E.; Vice-President, Morgan Engineering Company, Memphis, Tenn.

IMPROVEMENT of Drainage District 9, in northeastern Arkansas, includes the protection from overflow of Little River by an independent channel and levee parallel to the river; a system of lateral drainage canals throughout the entire territory, and the construction of outlet channels for the lateral drains, requiring altogether about 300 mi. of ditches and 25 mi. of levees. The methods of designing and executing the work and the provisions for developing efficiency and economy of construction plant are here presented.

This district, which is in Mississippi County, covers about 300 sq. mi., about half of which is cut-over timber land, the remainder being about equally divided between cultivated land and virgin forest.

Here, as in all other parts of the so-called delta region of the lower Mississippi, the streams have a tendency to build up the land along their banks with the material deposited during overflow. Thus, the Mississippi River flows along a ridge which slopes gradually back for several miles, the land along the river front being 20 ft. higher than the land 10 mi. back, while the land along Little River, which runs west of and parallel to the Mississippi River, is 5 ft. or more higher than the land 3 mi. to the east. The district in question lies in a trough between these two high-bank streams. Prior to the construction of the Mississippi levees, it was overflowed from both the Mississippi River and the Little River. The interior of the district is a flat, wooded swamp known as Tyronza Lake, or the Tyronza Sunk Lands.

Towards the south end of the district water flowing through this trough has formed a number of small channels which unite in the main channel known as Tyronza River. This is entirely inadequate to carry off the local rainfall of the district. Through the main part of the district, however, no natural channel has been formed. Much of the land around the rim of the district, especially along the Mississippi River, is in a high state of cultivation and has a market value of from $75 to $125 an acre. Nearly all the interior of the tract is in timber, which is being rapidly cut off. About half the district is now what is known as cut-over land.

The main features of the district plans are: (1) Protection from overflow from the Little River, (2) a system of lateral drainage through the entire territory and (3) a system of outlet channels to carry to a final outlet the water collected in the lateral drains.

LITTLE RIVER OVERFLOW

Little River rises in the Ozark Mountains in Missouri, spreads out through the low lands of Missouri, entirely losing its channel in the great wooded swamps, and then gathers its water together again in a channel near the State line between Missouri and Arkansas. After flowing through a single wide channel or lake for about 10 mi. it again divides, one of the forks losing itself in the woods, and the other continuing as a high-bank stream along the west boundary of this district. It is utterly inadequate for carrying off even the small amount of water which can find its way through 100 mi. of swamps in Missouri, and overflows during a large part of each year.

At the northwest corner of this district, with a drainage area of about 3000 sq. mi., it has a bank-full capacity of only about 1000 sec.-ft. The plans of the Little River District in Missouri provide for the construction of about 600 mi. of ditches, discharging into Little River at the State line, and for the diversion of the hill waters into the Mississippi River. The result of the work in Missouri will be that the floods in Little River in Arkansas will be higher than formerly, but of shorter duration.

It seemed inadvisable to levee the banks of the Little River. The stream is exceedingly crooked and is of such small capacity that levees on either side would have to be carried to an impracticable height. Careful estimates were made of the amount of water overflowing the banks of Little River to the east, and a channel was planned running parallel to and about a mile east of the river, with sufficient capacity to carry all of the overflow waters passing over the river bank to the east. The earth taken from this channel is deposited on the east side of the ditch to form a levee so that should a still greater amount of water overflow in the future, it would be restrained by this levee from flowing over the lands of the district.

DETERMINATION AND CONTROL OF OVERFLOW

The overflow of the river to the east is not general along its entire length, but occurs at well-defined breaks in the banks, locally known as "cutoffs." The investigations to determine the amount of overflow from the river were made by the writer personally. As the flow through these cutoffs was not sufficiently concentrated to make possible a direct measurement of the outflow, repeated current-meter measurements were made on the river above and below each of the breaks in the bank, and the difference in discharge was assumed to equal the amount flowing out of the river channel. Current-meter measurements were also made on Tyronza River below a point where it received all of the overflow waters.

The capacity of the Little River channel at the lower end of the district, at a stage when the water begins to leave the channel through ordinary low places in the bank, is about 1000 sec.-ft. The maximum stage is about 2 ft. higher, the small range being due to the large area of overflow. At such stage the capacity of the river channel is about 1200 sec.-ft. The volume of water passing out of the river through the upper of the two principal cutoffs, known as Feed House cutoff, is about 500 sec.-ft.; that passing through the lower, or Tyronza cutoff, is about 750 sec.-ft. The channel designed to carry the overflow water was given a greater capacity than that indicated by these measurements, in order to provide a factor of safety.

A much larger part of the waters of Little River overflows to the west away from the district than towards the east. As the river overflows to the east only at a few points, and as the channel above mentioned will carry almost the total amount of this overflow, the strip of land between the river channel and this artificial channel, though unprotected by levees, will to a large extent be reclaimed for cultivation, unless conditions are greatly aggravated as a result of the work of the Little River District in Missouri. The further control of Little River must come about as a part of another and larger project involving the reclamation of land lying to the west of the river.

LATERAL DRAINAGE

The investigations in the district for the purpose of planning lateral drainage consisted of a topographical survey and a system of soil borings and hydraulic investigations of the capacity of Tyronza River and other channels within the district. The topographical survey consisted of level and compass lines, crossing the district at intervals of from ½ to 1 mi., usually from east to west, but in some parts of the district, from north to south also, and in the traversing of all streams or depressions more than 3 ft. deep, and all ridges and elevations more than 3 ft. above the general ground surface. Cross-sections were made of all channels at intervals of about 2000 ft., and at shorter intervals, if particular features required development.

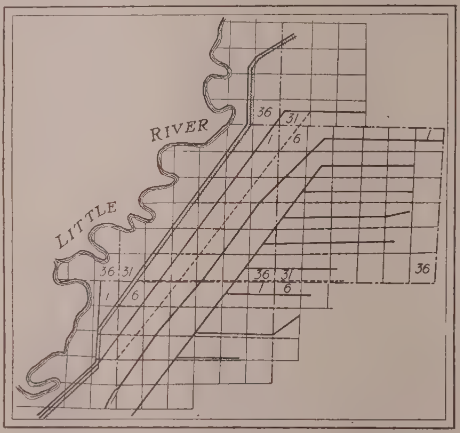
RUNOFF

No records of the runoff of the interior of the district were available, and on account of overflow conditions and the lack of small natural drainage channels on which measurements could be made it was impossible to determine accurately what the runoff would be. Moreover, the construction within the district would change runoff conditions so fundamentally that even if actual runoff measurements had been made they would not have been conclusive as to what would occur after the reclamation had been accomplished.

In the absence of such information it was necessary to base the design upon data secured on other similar areas where runoff measurements have been made. All available information was taken into consideration, including that secured by the Morgan Engineering Company, by the U. S. Government investigations and from miscellaneous sources. After a careful canvass of the situation, the accompanying formula and runoff curve were developed. These differ somewhat from similar data heretofore used, effort having been made to adapt them to the particular conditions obtaining in this district.

SMALL LATERALS

In case of the smaller laterals both locations and dimensions were determined not so much by consideration of the hydraulic factors as by practical working conditions. Nearly all land in this territory is held in sections or fractional parts of sections. There was a strong demand on the part of landowners that the drainage channels should follow the boundary instead of cutting irregularly across tracts. On the whole, therefore, the locations of the smaller laterals follow section and quarter-section lines. In the case of the larger channels, or where there are marked features of topography, these considerations are ignored. As the general surface slope within the district is to the southwest, it was in many cases possible to locate ditches either north and south, or east and west, and secure sufficient fall for good drainage.



TWO SCHEMES OF DRAINAGE CONSIDERED

Dotted lines indicate "fish-bone" system rejected. Heavy solid lines show four-channel plan adopted. Numerals show corner sections of townships.

In determining the cross-section of the smaller laterals it was found that the controlling factor was the machinery with which the work must be done. With the exception of a few small ditches lying on comparatively high land, the minimum channels within the district were planned with a bottom width of 14 ft., slopes ½:1, a top width of about 22 ft. and a depth of about 8 ft., in order to accommodate the most advantageous excavating machinery. Hence many of the lateral ditches have a capacity much in excess of that required.

This excess capacity is of very great value to the district. Within a year or two after construction of any of the ditches there is a tendency for the banks to cave and crumble in the process of weathering. If a drainage system is constructed of approximately the proper size upon its completion, therefore, it will in the course of a few years be entirely insufficient as a result of this depreciation. The channels of this district were planned to have a capacity of perhaps 25 per cent in excess of the maximum requirements. In addition to this, the actual excavation in the smaller laterals will average perhaps 25 per cent in excess of the theoretical cross-section. The system, therefore, will remain fully serviceable even after a material amount of depreciation has taken place.

After collecting the drainage of the territory in the lateral ditches it is necessary to convey the waters to a final outlet from 20 to 40 mi. distant from the outlets of the laterals. A former plan for the drainage of this territory was outlined on what might be called a "fish-bone" system; that is, one main outlet ditch was planned through the lowest territory with laterals 1 mi. apart running in a course generally normal to the outlet. This plan was abandoned and a system of parallel channels about 1 mi. apart was substituted. The two methods are illustrated. The solid lines indicate the system of parallel ditches as finally constructed; the dotted lines indicate the general type of the plan first proposed.

There were two principal reasons for making this change: First, a single outlet channel would of necessity have been about 100 ft. wide on the bottom, about 15 ft. deep, and about 130 ft. wide on top, with a cross-sectional area of about 1700 sq. ft. As it would have been located along the lowest land, the most effective distribution of slope could not have been secured. A greater slope than necessary would have occurred at the upper end and a flatter slope than desirable at the lower end. By dividing the outlet of the ditches into four separate channels it is possible to carry two of these on somewhat higher ground with more nearly uniform gradients throughout, and thus counterbalance the loss in hydraulic mean depth by the gain in uniformity of slope.

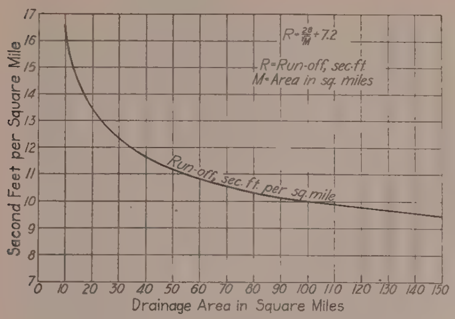
The four parallel ditches with bottom widths in two cases of 40 ft., one of 50 ft. and one of 20 ft., have a combined cross-sectional area perhaps 5 per cent in excess of what would have been necessary for a single channel. They not only serve the purpose of outlets, however, but also perform the function of laterals in their immediate vicinity. They make unnecessary the 3 mi. of lateral ditch for each mile of outlet channel which would have been necessary under the other arrangement, and effect a saving of about 90,000 cu. yd. of excavation, or about $6,000 per mile of the length of the valley.

CONSTRUCTION EQUIPMENT

In planning drainage work a study of economical equipment available for construction is as important as the study of hydraulic features. The most feasible machinery for the construction of these ditches is the floating dipper dredge, and its limitations are very definite. The smaller economical limit was determined in the construction of lateral ditches. The larger limit was determined and considered in fixing upon the size of the largest outlet channel.

The largest channel in this district has a bottom width of 50 ft. and a cross-sectional area of 800 sq. ft. It is being dug by a floating dipper dredge of 4½-yd. capacity with an 85-ft. boom, this being the largest dipper dredge ever constructed for reclamation work where the earth must be deposited along the sides of the channels excavated.

It is being found during construction that this ditch has somewhat exceeded in size the most economical section for dredge work, and the dredge is continually strained to its limits in depositing the dirt. Moreover, there is a strong tendency for the waste banks to break down and slide toward the ditch, making necessary the cutting of a channel in two installments. In such cases about half the prism of the ditch is first taken out, the excavation be-



RUNOFF FORMULA AND CURVE USED

ing in some cases to the full top width of about 75 ft. At the second cut all material is deposited back of the first waste bank, which about this time has become settled and stable, and prevents the remainder of the material sliding toward the ditch when it is deposited. The first waste bank attains a height of about 8 ft. The second is as great as 12 or 15 ft. The slope on the stable part of the waste bank is usually about 2½:1. Our investigations show that in general, where only one cut is necessary, the waste banks ultimately attain a slope of 2½:1 on each side assuming that the top of the waste bank is a narrow ridge. In the double cut the rear slope is considerably flattened, the front slope being about 2½:1.

DITCH 6 WITH LEVEE EXTENSION

One of the largest outlet ditches in the district is ditch 6, which traverses Tyronza Lake and has a base of from 35 to 40 ft. and a carrying depth of 12 ft. The slope of the ground surface for the lower 20 mi. is so slight that it was not possible to secure a fall greater than 3 or 4 in. per mile for this ditch. At the lower end the back water from Spear Lake raises the flow line so that it is necessary to construct a continuous waste bank on the east side of the ditch for 10 mi. The large outlet ditch below Spear Lake has a much greater fall than both of the ditches above, so that it was laid out with a base 40 ft. wide, side slopes 1:1 and a carrying depth of 13 ft.

Continuous waste banks were left along this ditch, and the maximum flow line will be about 5 ft. over the general ground surface between these waste banks. The object of this construction was to secure the greatest possible discharge for the least amount of excavation, it being found feasible to levee an artificial channel, just as it is sometimes feasible to levee a natural channel rather than enlarge it to carry the required flow. It is specified that the waste banks shall be at least 3 ft. higher than the maximum flow line and that they shall have a crown width of 6 ft. and side slopes of 2:1.

These levees will not be overtopped, as the water would pass over the banks of Spear Lake before this could happen. The waste banks, or levees, as in fact they are, are set 20 ft. back from the edge of the ditch. Calculations show that in case the ditch should cave back far enough to endanger the levee the ditch will have been enlarged to such an extent that the water would be carried below the ground surface, and the levees would no longer be necessary.

In the design of the ditches, Kutter's formula was used. A value of 0.025 was used for "*n*." Since the design of this district we have decided that a value of 0.030 is more nearly correct for channels in this part of the United States. While the lower figure is about right for clean, new, smooth channels, it is not large enough for channels after vegetable growth has formed, or after obstructions have occurred. The slope in the larger ditches of the district is very slight, varying from 3 to 6 in. to the mile, except for the outlet ditch below Spear Lake. According to our calculations the maximum velocities in these ditches, where the slope is low, will be from 1½ to 3½ ft. per second. The velocity in the outlet ditch below Spear Lake will be about 3½ ft. per second under extreme conditions.

Economy of construction was materially promoted by the very small slope of many of the laterals. On the more important ditches with very flat slopes, economy was further effected by the pains taken to adjust the character and dimensions of excavation and embankment to the limitations of standard existing machinery. Also, the cost was reduced by analysis of the problem, separating the care of overflow water from that of local drainage, making distinct, independent systems at a smaller combined cost than would have been possible for a single large channel.

CONSTRUCTION, COST AND MAINTENANCE

Under the State drainage law the revenue for carrying on this improvement is derived from special assessments levied on the land in the district in proportion to the benefits received, and collected by the usual tax-collecting machinery. The district is incorporated, and its officers are appointed by the Court. The anticipated average benefits in the improvement are estimated at a total of about $20 per acre, the cost of the work being on the average about $7 per acre. The value of the land, before the improvement was undertaken, was from $10 to $20 per acre for cut-over timber land, and from $50 to $75 per acre for cleared land. It is believed that all of the land, after the improvement is completed and the soil cultivated, will be salable at from $75 to $150 per acre.

It is anticipated that the only maintenance required for this drainage system, after it is first put into complete operation, will be the annual removal of plant growth from the ditches at a cost of from $15 to $50 per mile each year. The ditches may require redredging to deepen them after a long period of years. In the meantime the lands may become so valuable that more detailed drainage will be justified and additional dredge ditches will be dug between the ones already planned, so as to furnish outlets more closely adjacent to all parts of the district. Drainage has been carried to this degree of refinement in some northern localities.

Slightly more than 14,000,000 cu. yd. of excavation is contemplated in the plans. The estimated cost of the excavation, divided into sixteen contracts, was $1,155,000, but the contract price was only $979,950 on the same yardage.

Contracts for this work were let in January, 1912. The rainfall was comparatively light for the following summer, so that although a few of the dredges were built ready for operation about August, only two machines started before January, 1913. Four of the dredges have had sufficient water to operate continuously, but the remainder have been shut down each summer on account of the scarcity of water to float them. The work has thus been very materially retarded and is now only about 45 per cent completed.

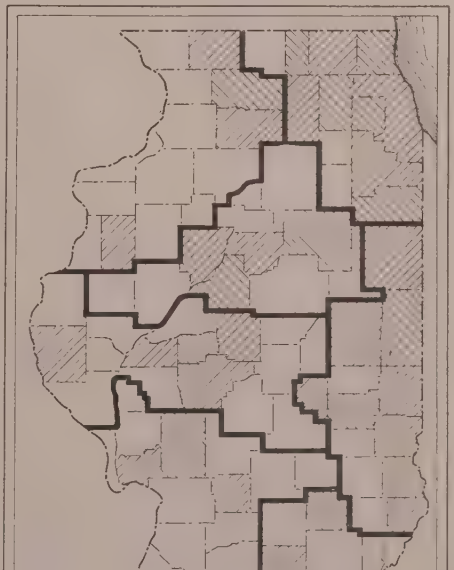
Organization of Illinois State Highway Department

Notes on Manner in which Road Improvements Are Supervised and General Outline of Work Now on Foot or Contemplated

NOT until July, 1914, did the Illinois State Highway Department, authorized the year before by the Tice road law, know whether or not it was to obtain backing in the shape of an appropriation. On July 1, 1914, the appropriation for 1913-15, amounting to $1,100,000, was made available. As the result of the delay in financial aid, the highway department, which now consists of a force of eighty persons, has been virtually organized within a few months. Since July 1 fifty-one separate contracts, covering 82 mi. of road, have been let. Of this, 70 mi. are of concrete and 12 mi. of brick construction. The State has been divided into seven districts and plans have been made for a program which will add or make anew 15,000 mi. of road.

ORGANIZATION

The State Highway Department consists of a State highway commission, the chief State highway engineer, the assistant State highway engineer and the various subordinate officers appointed under the civil-service laws of the State. The State Highway Commission consists of three members appointed by the Governor with the advice and consent of the State Senate. The State highway engineer and his chief assistant are appointed for a term of six years in the same manner as the commission. Directly under the assistant chief come the bridge engineer, who has charge of the construction and design of bridges; the road engineer, who has charge of all experimental and State-aid road work, and a chief clerk, who has charge of the office force. The bridge and road engineers each have a chief assistant. The chief assistant to the road engineer takes complete charge of ex-



THE SEVEN DISTRICTS IN ILLINOIS

Highway contracts have been let in the cross-hatched counties perimental road work. There are six experimental road projects at present, and as there is a resident engineer on each, the chief assistant to the road engineer has six residencies reporting to him. Attached to both the road and bridge departments are a number of assistants, including draftsmen.

Reporting to both the bridge and road engineers are seven division engineers, heads of the seven State highway districts. Under each division engineer there are a number of resident engineers, depending on the amount of work to be done in the district.

The new road law provides that each county should have a county superintendent of highways. He is subject to the rules and regulations of the State Highway Commission, is directly responsible to the county board and is a deputy to the State highway engineer. His duties are to prepare plans, specifications and estimates for all bridges to be built by the county. He acts for the county in all matters relating to the supervision and construction of roads, visits and inspects all the highways and bridges in his county at least once a year, supervises all repairs and keeps a record of all contracts or purchases of materials, machinery or apparatus in excess of $200.

WORK TO DATE

Immediately after the Tice law was passed plans were outlined for a 15,000-mi. road program, and maps were made for each of the 102 counties of the State, together with duplicates for the State file. Up to the present time ninety-nine county superintendents have been appointed out of the 450 candidates for the positions presented by the various county boards. Last January the State University held a two-week road school, which was attended by not only the newly appointed county highway superintendents, but also by many of the State force. In addition to the regular work now in progress, six experimental road projects are being carried out.

EXPERIMENTAL ROAD WORK

For ten years prior to July, 1913, the State maintained an experimental road department and had eleven road outfits, three of which were for concrete road work, the other eight being used for bituminous and waterbound macadam. Two of the most interesting experimental road projects at present are those at Beecher, where convict labor is being used to build 13 mi. of macadam road (see the Engineering Record of Aug. 15, page 189), and in LaSalle County, where private interests are building 22,000 ft. of concrete road. The Marquette Manufacturing Company, desiring a well-built outlet for its LaSalle County plant, is furnishing the money to the county and the county obtained the use of the State equipment and engineering force. The work involves 28,000 cu. yd. of cut, which is being done in conjunction with reducing a 12-per cent grade to 7 per cent. Among the other experimental projects are 4 mi. of concrete road at Mount Vernon, 3 mi. of bituminous macadam at Oregon, and 3 mi. of concrete road at Bridgeport and Petrolia. The resident engineers on these experimental projects take direct charge of the construction, engineering, labor and ordering of material.

In carrying out all State-aid road work the State and county each assume half the costs. When a road becomes a State-aid road the law provides that the State shall agree to maintain the road forever.

The accompanying map shows the seven districts into which the State is divided, together with the counties in which contracts have been let since July 1, 1914. The highway department was organized under A. N. Johnson, chief engineer, recently resigned. P. C. McArdle is now State highway engineer.

Railway Power Station at Louisville

A Steam Turbine Plant of 48,000-Kilowatt Ultimate Output with a Condenser Water System of 230,000,000-Gallon Daily Capacity

DIVERTING sewage from Beargrass Creek in Louisville, Ky., by intercepters is primarily responsible for the location of the new station of the Louisville Traction Company on the Ohio River at High Street rather than extension of the existing Campbell Street Station. Formerly 90 per cent of the water flowing in the creek was sewage, making it necessary for the company to sink artesian wells and use a spray-cooling system when the intercepters began to be put in operation five years ago. Water became limited and expensive, so reducing the efficiency of the plant that a new site on the river was sought when the old plant had outgrown the property it occupied and reached its capacity, the maximum hour load having risen from 3000 kw in 1900 to 15,000 kw in 1912.

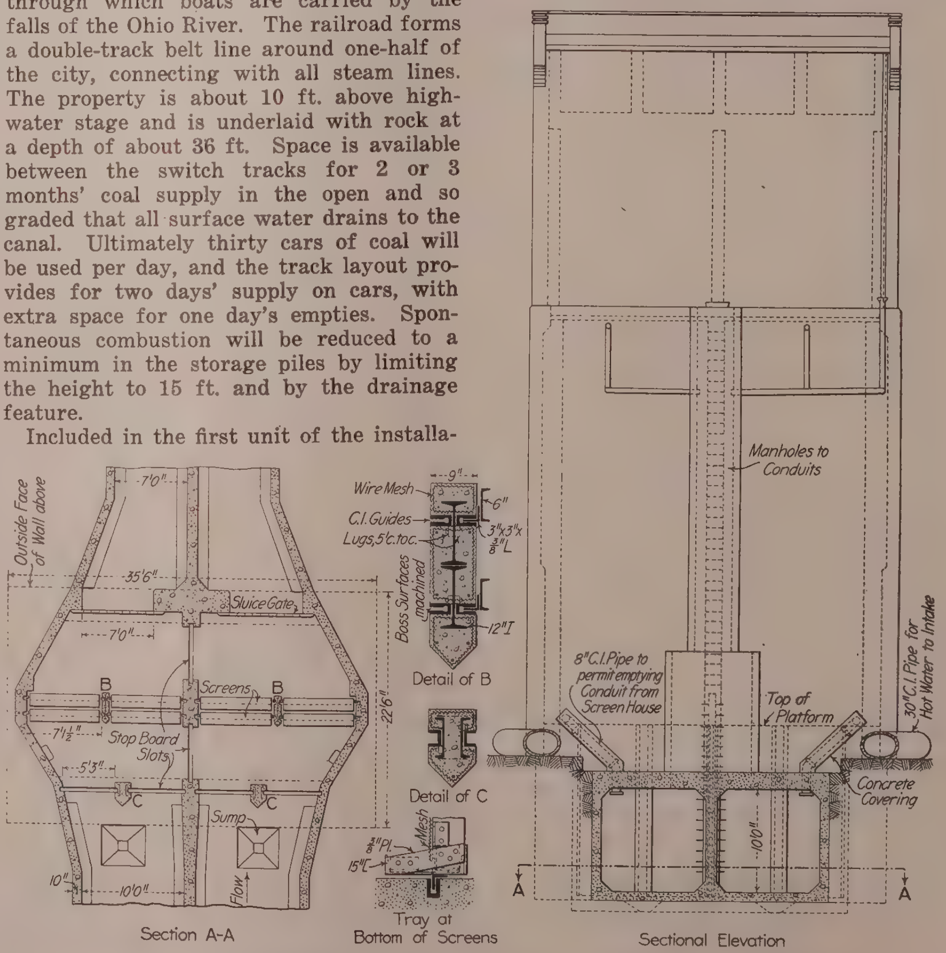
The company operates 165 mi. of city track and 96 mi. of interurban lines. The new station, with its initial capacity of 12,000 kw and an ultimate capacity of 48,000 kw, will feed the transmission system at 13,200 volts, 25-cycle, three-phase at two city and six interurban substations.

The location selected for the new plant fronts on the Kentucky & Indiana Terminal Railroad Company's right-of-way and adjoins the Louisville and Portland Canal, through which boats are carried by the falls of the Ohio River. The railroad forms a double-track belt line around one-half of the city, connecting with all steam lines. The property is about 10 ft. above high-water stage and is underlaid with rock at a depth of about 36 ft. Space is available between the switch tracks for 2 or 3 months' coal supply in the open and so graded that all surface water drains to the canal. Ultimately thirty cars of coal will be used per day, and the track layout provides for two days' supply on cars, with extra space for one day's empties. Spontaneous combustion will be reduced to a minimum in the storage piles by limiting the height to 15 ft. and by the drainage feature.

Included in the first unit of the installation is a boiler room, 100 x 180 ft. in plan, built with the long axis at right angles to the 80 x 175-ft. turbine room. The latter houses two 6000-kw Westinghouse, double-flow, steam turbines and generators, each equipped with a 20,000 sq. ft. Worthington surface condenser. A foundation is provided for one additional unit and space is left for a fourth. In the boiler room are eight 507-hp B & W boilers set in a row, with spare space for an additional row of eight. Above the concrete substructure the fireproof buildings are of brick and steel, with concrete floors. For natural light large window space, fitted with Fenestra sash, is provided in both boiler and turbine room. A double monitor skylight surmounts both rooms, that over the boilers is inclosed with asbestos-board corrugated siding.

FOUNDATIONS

Foundations for the steam turbines consist of two parallel walls resting on solid rock and extending upward to within 18 in. of the main-floor level. The two walls are spaced far enough apart to allow the surface condenser to be dropped into place by the 50-ton Whiting crane serving the turbine room. The turbines rest on grids



PLAN AND ELEVATION OF SCREEN HOUSE AND TUNNEL CONDUITS

DISCHARGE TUNNEL TIMBERED AND READY FOR CONCRETE LINING

of I-beams placed over the concrete walls. Sufficient steel was placed in the concrete mats forming the basement floors to withstand an upward hydrostatic pressure of 45 ft. due to extreme high water in the Ohio River. Foundations for the stack and caisson foundations for the main boiler and coal-storage bin supports were extended to rock, while foundations for floor supports and intermediate boiler supports rest on concrete mats built on concrete piles driven to rock or refusal.

STACK

For the initial installation a Heinicke chimney, 13 ft. in diameter and 255 ft. in height, has sufficient flue area to provide a square foot for each 36.25 hp.

Tests made to ascertain the draft at the base of the stack and over the grates, above which the chimney top is 253 ft., indicated vacuums of 1.2 in. and 0.45 in. of water respectively. This was with only six boilers in service, and the grate test was with the main breeching and boiler dampers open. At the last boiler pass the vacuum was 1 in. Preliminary tests of boiler and station efficiency during the second month's operation, before all steam pipes were covered, gave a coal consumption per kilowatt-hour of 2.975 lb., with 12.5 per cent ash. The coal was Western Kentucky pea and slack, testing 12,000 B.t.u. dry.

COAL AND ASH-HANDLING EQUIPMENT

Coal is received from the steam road connection into concrete unloading hoppers at one end of the boiler room. Two-ton pushcars, loaded from the hoppers, convey the coal to structural-steel bunkers over the boiler room after being raised by one of the two electric elevators. An industrial railway is laid from the elevator shaft over the bunkers so that the car may be pushed by hand to any desired point. Over each battery of two boilers is a coal bin holding 225 tons, equivalent to four and one-half days' supply. The large storage was provided as a precaution against shortage during high-water periods when the railroad tracks might be inundated.

Ashes drop from the B & W chain grates into two steel ash hoppers lined with firebrick, and are dumped into pushcars on an industrial track. Siftings from the grates are caught in one hopper, from which they are returned to the coal bunker by the pushcars. Ashes are elevated over the coal unloading tracks to a steel ash hopper lined with firebrick.

The elevator system was adopted because the engineers believed it would be low in first cost and maintenance. In comparison with a bucket-conveyor outfit installed at the Campbell Street station the cost of handling coal and ash is approximately 20 per cent less.

CONDENSED-WATER SUPPLY

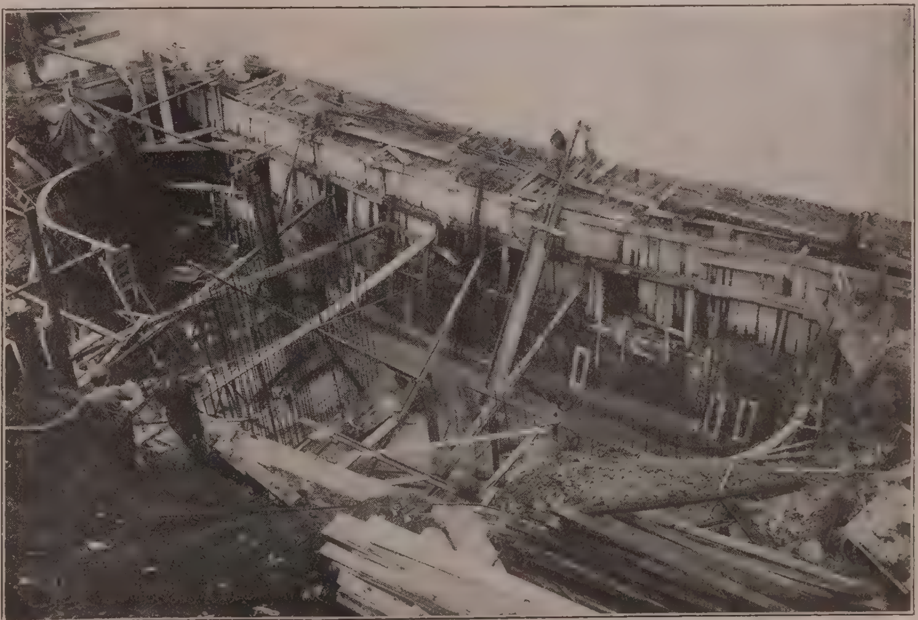
Ultimately 230,000,000 gal. daily of cooling water will be required for the condensers of the eight 6000-kw units. The intake conduits for this enormous quantity of water have already been constructed to the end of the present building, while the discharge conduit has been completed for the ultimate extension. This quantity is based on an assumption that 110 times the volume of the condensed steam is required with condensing water at 75 deg. Fahr. and with the maintenance of a 28-in. vacuum.

Water is taken from the canal through eight openings, 4 ft. 8 in. wide and 8 ft. high, with the sills on the bottom of the canal a level 50 ft. below the generator-room floor. The normal depth of the water in the canal is 12 ft., the 4-ft. submergence being counted on to pass much of the floating trash. Within the intake structure and at right angles to the canal wall are four removable wrought-iron racks inclined 20 deg. from the vertical. They are composed of ½ x 4-in. bars set 2 in. apart to retain large trash which may be removed through openings in the roof at the level of the canal bank. To eliminate interference with small boats the velocity at intake and discharge openings is 1.19 ft. per second.

A second set of screens is installed in a screen house located on the railway company's property 90 ft. from the intake. Two 10 x 10-ft. concrete conduits, connecting the intakes and the screen house, are laid under the steam railroad right-of-way. At the screen house the intakes flare to provide supports for stop planks and a double row of removable vertical screens. The latter have been installed with four double screens in each of the four panels. In each panel the screen nearest the intake is of ⅞-in. mesh No. 8 copper wire, and the second screen is ½-in. mesh No. 10 copper wire. Each screen is set in a substantial angle iron frame, 7 ft. ¼ in. wide x 14 ft. 9 in. high, and these frames have four 3 x 3 x ⅜-in. angles which slide in cast-iron vertical slots set in the concrete. A 3-ton Whiting electric crane installed on runways has been provided to raise and lower these screens.

Twin concrete intake conduits, 7 ft. wide x 8 ft. high, lead from the screen house under circulating pumps in the turbine room. These are protected by 7 x 8-ft. Chapman sluice gates operated from the screen-house floor. The intake conduits slope from the canal to the turbine room on a 1 per cent grade, and all the pumping equipment was so designed and installed that water may be taken from either or both intakes. In order to facilitate cleaning, manholes with tops at the property grade have been installed every 100 ft. The complete intake and discharge system has been designed to facilitate future extensions to the station.

Circulating water from the turbine-driven, 26-in. Worthington trirotor cen-



BUILDING THE POWER STATION INTAKE BACK OF AN EARTH COFFERDAM trifugal pumps, with which each unit is equipped, discharges into the canal 500 ft. below the intakes and by way of a 9 x 9-ft. reinforced-concrete horseshoe-shaped conduit. It was built part in open cut and part in tunnel each way from manhole openings, spaced 100 ft. apart. The invert rests on the top of the rock formation. The flow line of the discharge conduit is 1 ft. above the normal river stage at the turbine building and descends on a 0.22 per cent grade toward the canal. Discharge pits have been built into the discharge tunnel below the flow line to seal the condenser discharge water.

Discharge Conduit and Openings

The discharge conduit crosses the steam railroad right-of-way at right angles, then turns parallel to the tracks and canal, with eight openings from the discharge ducts through the canal wall in a distance of 112 ft. 6 in. The tops of these discharge openings into the canal are 5 ft. below normal water stage, and the takeoff ducts dip sharply from the main conduit to the canal outlet. The extreme end of the 9-ft. main conduit is temporarily closed so that future extension parallel to the canal, providing additional openings into the canal, may be made when necessary, or, if so desired, the circulating water may be discharged farther downstream from the intake.

Laid along the intake conduits are two 30-in. cast-iron pipes just over the outside walls of the conduits. These pipes are continuous from the discharge-water conduit to the outlet at the canal end of the intake and were provided to protect the intake from clogging with needle ice by discharging hot water into the canal at the mouth of the intakes.

Construction

Great difficulty, according to the engineers, was encountered in excavating and rock blasting from the water which lay above the water level in the canal and that in the canal itself. The intake conduits for their entire length were quarried in the open from solid rock. However, for 135 ft. of tunnel near the entrance to the building, where the space available was narrow between the property and the building lines, tunneling methods were resorted to.

Earth excavation for the turbine room, 41 ft. to rock, was carried on day and night by three Thew shovels through an assorted dump of ashes, tin cans for 16 ft., and, in succession, below yellow clay, blue clay, sand and gravel. The latter was water bearing and the pit required constant pumping by Nye pulsometer pumps until the excavation was sealed with concrete. The rock excavation consisted of 2 ft. of slate underlaid with hard limestone and softer concrete rock about equally divided. Material from the deeper excavation inside the sheeted portion was raised by means of a Lidgerwood cableway. At the canal the excavations were made behind earth-filled cofferdams, which were hard to make watertight against the 15 to 20 ft. of water on account of the rough rock surface. Part of the trouble at the discharge works was due to the thin cofferdam necessary to permit passage of a wide 75-ft. Government snagboat in a 78-ft. canal width.

Concrete of Speed Portland cement, sand and gravel obtained from the Ohio River was mixed in a 1-yd. Smith mixer and was deposited directly into place in the substructure from a 75-ft. tower. A 1-yd. Ransome mixer was also used on the work.

When the twin intake conduits passed under the railroad the latter was held up by 60-in. riveted girders, 60 ft. in length, supported by wood piles driven to rock before any excavation was attempted. The horizontal pressures due to the earthfill, about 41 ft. above the rock, were taken by cross-braces spaced about 15 ft. apart vertically and 10 ft. horizontally.

D. X. Murphy & Brother were the architects for the station, for which the Henry Bickel Company, of Louisville, was the contractor for foundations and excavations. F. H. Miller, electrical and mechanical engineer of the motive power department of the Louisville Railway Company, had charge of the design and construction.

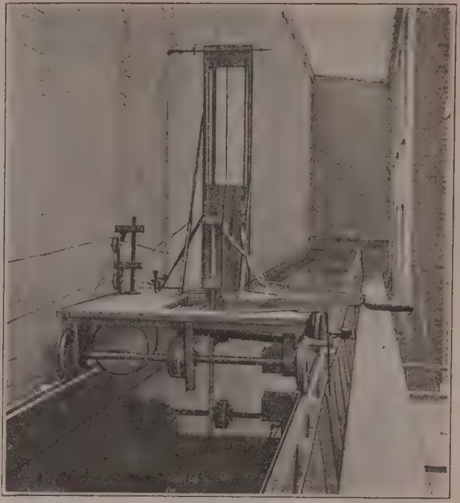
Rating Current Meters Unassisted at Rensselaer Laboratory

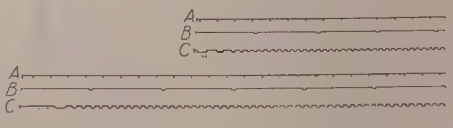
One-Man Apparatus Consists of Tank, Car, Chronograph and System of Electrical Control

By CHARLES P. RUMPF
Brooklyn, N. Y.

What is believed to be a unique scheme for rating current meters has been successfully used in a series of tests recently conducted in the laboratory of the Rensselaer Polytechnic Institute. A method was devised by which one person could run the car holding the current meter, and at the same time, with the aid of a chronograph suitably rigged up, obtain the necessary data for plotting rating curves.

The accompanying illustrations show a view of the car and tank used and a diagram of the necessary wiring. The chronograph drum is driven through the gears by a hanging weight that imparts uniform motion, and the gears may be shifted so that the drum revolves once in 15, 30 or 60 seconds, depending on whether the car is run fast or slow. Three pens, *A*, *B* and *C*, filled with a special non-clogging ink, trace independent lines upon a sheet of paper, fastened around the drum, as the drum revolves. These pens are pivoted in the center and held in position by small springs except when a current, passing through the electromagnets, *E*, causes a pen to be pulled sideways for an instant; this motion makes a notch on the pen's paper record.


APPARATUS FOR RATING CURRENT METERS



PART OF CHART MADE BY PENS A, B AND C

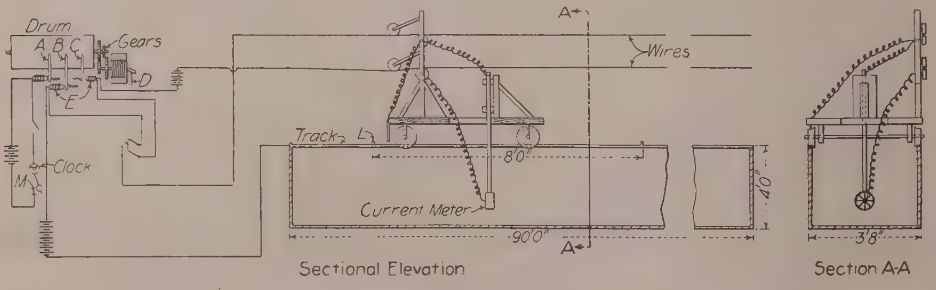


DIAGRAM SHOWING ARRANGEMENT OF APPARATUS AND ELECTRIC WIRING

The Three Pens

Pen *A* is moved every second when the pendulum of a standard clock passes through the mercury dish *M*. Pen *B* is pulled whenever a spring on the car makes contact with the lugs *L* on the track. Pen *C* is actuated every revolution of the current meter by connections found on nearly all meters.

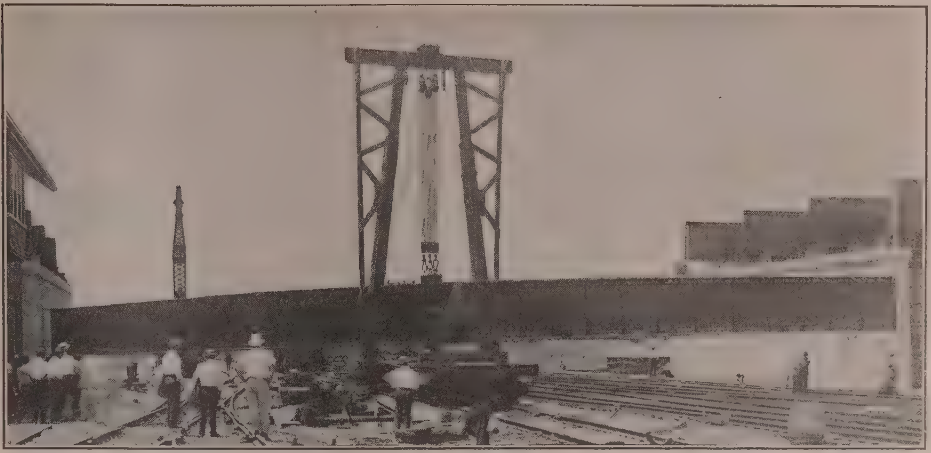
The procedure is as follows: At the start of a run a friction clutch on the chronograph is disengaged and the drum starts revolving. The car is pushed along the track at a uniform speed, a tachometer being attached to one of the wheels of the car so the speed may be observed. When the car reaches the far end of the tank the chronograph drum is stopped revolving by pulling a string, shown at the right in the photograph, which is stretched along the tank and fastened to the friction clutch which binds the drum. Both high and low speeds were recorded equally well. A brake on the car was of much assistance in stopping the car after fast runs.

A sample of records obtained is shown. Line *A* shows the seconds; line *B* the distances—in this case the lugs on the track being spaced 8 ft. apart; and line *C* shows revolutions of the current meter. Taking any one of these three functions as a basis, the relations of the other two to it may be found, and having the seconds, feet, and revolutions, the finding of the two necessary factors feet-per-second and revolutions-per-second is obvious.

The Yellow Pine Grading Rules referred to in the foreword to the article on page 387 of the issue of the Engineering Record of Oct. 3 have not been adopted by the Yellow Pine Manufacturers' Association, but have merely been approved and recommended by a committee of that association. They will not become the formal rules of the association until adopted at a general meeting. The rules were reported by the committee May 4 and not March 4.

Erecting Long Girders with a Gallows Bent in Kansas City

Details Are Given of Bolt Hitches and Method of Raising 76-Ton Girders with a Single Cable Rove from the Center



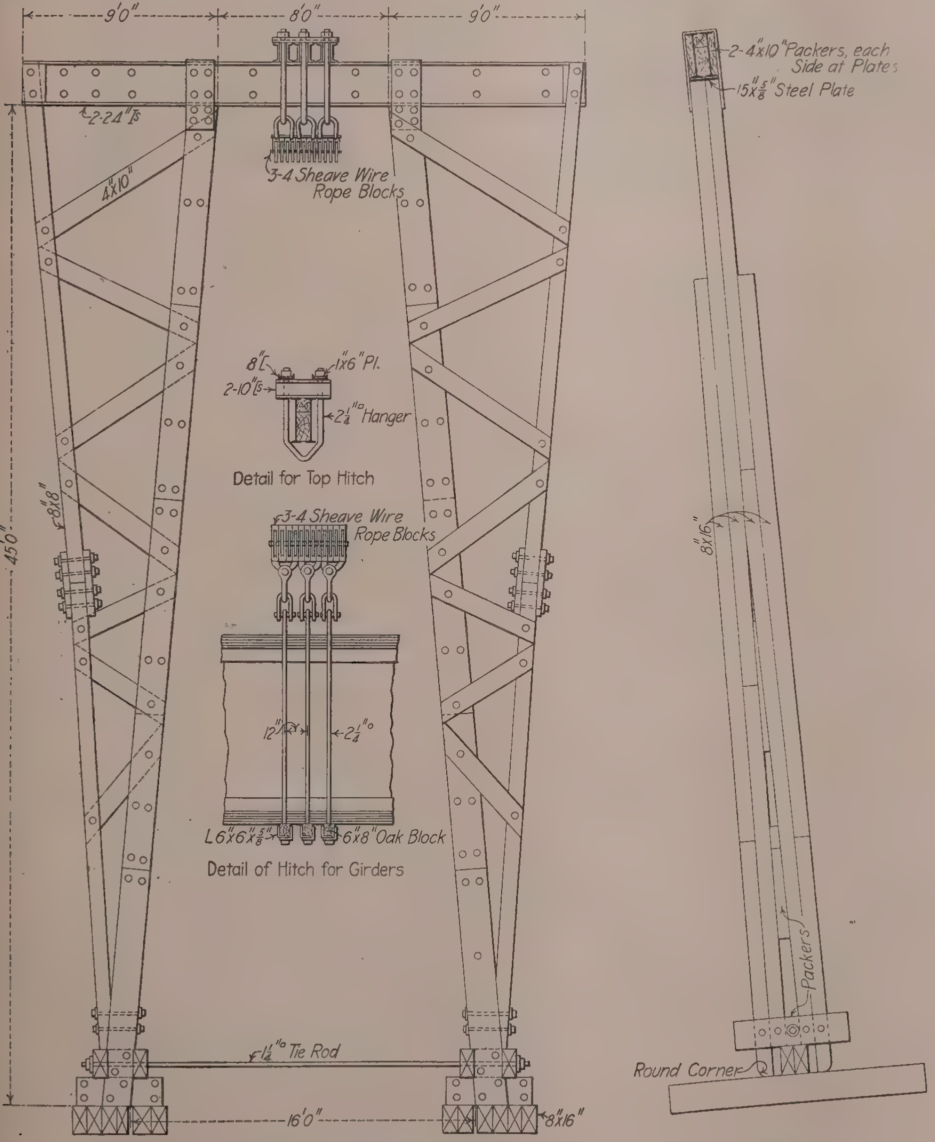
SWINGING A 127½-FT. PLATE GIRDER FROM A GALLOWS BENT

FIVE 127½-ft. steel plate-girders spanning the tracks of the Kansas City Terminal Railway Company at Pennsylvania Avenue were erected recently by means of a huge gallows bent set at an angle over the three cars on which each of the girders was shipped. At all other streets it has been possible to keep the spans to much shorter lengths by erecting piers between the tracks, but at Pennsylvania Avenue the crossovers in the track layout prevented this method from being used. The viaduct crosses the tracks on a skew of 69¼ deg., and the steel portion has a total length of 551 ft., made up of seven spans of four girders each and this long one of five girders weighing 1142 tons. Two of the long girders weigh 76 tons, two, 66 tons, and the fifth, 69 tons.

At the center of the heaviest girder the section is 8 ft. back to back of flange angles, made up of a web plate 96 x ⅝ in., and at the top and bottom, two 8 x 8 x 1-in. angles, two 18 x ¾-in. plates and four 24 x ⅞-in. cover plates. Loads assumed on the viaduct, which is 79 ft. wide, out to out, with 9½-ft. sidewalks, are two 50-ton street cars, a 17-ton road roller and 100 lb. per square foot for ordinary traffic. Over the 8-in. concrete deck was laid a wood block pavement, but the concrete was first waterproofed with three-ply fabric coated liberally with asphalt.

Holes through the web, shown in the photograph, were left to attach the wire mesh over which was applied a 3-in. layer of concrete by a cement gun.

Details of the gallows frame and the hitches to the girder by three 2¼-in. bolts are shown in the drawing. The 45-ft. height gave a clearance between the blocks of 23 ft. A single new ¾-in. wire cable, 1200 ft. long, was rove through the three four-sheave blocks from the center and each end led to a snatch block at the foot of each gallows leg; thence it passed to a locomotive. This method was adopted to equalize the strain on the rope.



GALLOWS BENT FOR ERECTION OF VIADUCT IN KANSAS CITY

ERECTION OF FIRST GIRDER

Advantage was taken of the skew by erecting the east girder first, there being just sufficient clearance to permit the ends of the swinging girders to pass the ends of those already in place. Erection of the first girder was delayed about 1 hr. while the hitch was shifted slightly to obtain a perfect balance. Unequal friction in the three blocks made it impossible to maintain such a balance. The contractors then snubbed each end of the girder and no further difficulty was encountered. Only a few minutes were spent in raising each girder, most of the 5-hr. period required for each girder being taken up in tipping and resetting the gallows bent with a wrecking crane. Traffic was suspended only a few minutes from the time the girders were swung clear of the cars until they rested on the piers.

Actual working time consumed in the erection of all the girders was 29 days of 8 hr. each, the total period elapsing, however, being 41 days.

The Kansas City Bridge Company was the contractor for the erection of the steel which was furnished by the American Bridge Company. C. S. Tupper, superintendent and J. B. Neely, engineer in charge for the contractors, worked up the gallows frame scheme. The erection was carried out under the direct supervision of George E. Tebbetts, bridge engineer for the Kansas City Terminal Railway Company, of which John V. Hanna is chief engineer.

MORE NEW TIES AND RAIL were laid on the lines of the New York, New Haven & Hartford Railroad during the fiscal year ended June 30 than during any previous year in the last decade. The total number of new ties laid was 2,060,485, as compared with 1,814,190 in 1913 and 1,493,786 in 1912. Of last year's consumption, 79 per cent, amounting in price to $1,374,160, were produced along the company's lines. A total of 25,783 tons of new rail were laid, as compared with 22,610 tons in 1913.

Waste-Water Disposal at Sugar Factory

Comprehensive Study of Sugar Waste Sanitary Problem in California Followed by Construction of a Screen and Intermittent Sand Filters

A REVOLVING fine screen of the sewage-treatment type and intermittent sand filters successfully cared for the rich quickly-septicized organic waste water from a sugar factory at Anaheim, Cal., during the 1913 season. Southern California and especially Orange County raises great quantities of beets and in addition to the one at Anaheim, there are factories at Oxnard, Chino, Betteravia, Los Alamitos, Santa Ana and Long Beach. All of these factories, with the exception of the one at Anaheim, either discharge their wastes into the ocean or use them for the irrigation of lands which they control. The Southern California Sugar Company's factory at Santa Ana has a vitrified pipe outfall 9 mi. long to the ocean. The American Beet Sugar Company at Oxnard has an open canal from its factory to the ocean.

The Anaheim Sugar Company began operations in 1911 and during the campaign of that year discharged its wastes to the west of the plant on a portion of a 55-acre factory site. Shortly thereafter various complaints were filed with health boards, because of the disagreeable odor from decomposing vegetable matter, but no definite action was taken against the company. For the campaign of 1912 a 20-in. steel pipe line was laid 1500 ft. north to a ditch of the Anaheim Union Water Company; another line of 20-in. reinforced-concrete pipe was laid to the southeast to the Anaheim Canal of the water company.

When the campaign started there was so much organic suspended matter thrown into the pipe line and thence into the canals and ditches, that complaints were made by those living in the vicinity and this outlet was shut off. The company then leased a 40-acre tract adjoining the factory site on the east and on this land a 10-acre area was enclosed by a levee. For two months this lagoon received all the wastes and in less than four weeks septic action was established with all the attendant strong sulphur odors, apparently mainly sulphuretted hydrogen. Complaints were made to the State Board of Health, but the factory was allowed to complete the campaign. The odors ceased as soon as the lagoon was drained at the end of the season.

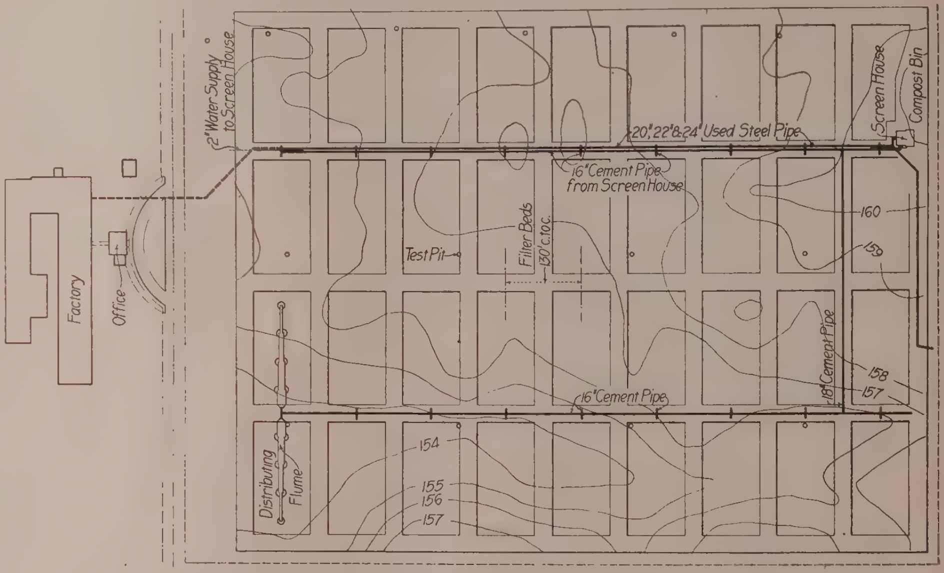
Before closing down in 1912 the service of engineers was secured and for the first time the wastes from a sugar factory in California were comprehensively studied and the problem of scientific treatment investigated.

CHARACTER AND COMPOSITION OF WASTES

Water is used in almost every process of sugar making. In this case it enters the factory clear and colorless and leaves it dirty and discolored and heavily laden with suspended matter, much of which has a specific gravity less than water. The suspended matter contains sand, clay and silt, washed from the beets, and beet tops and roots and rejected beets. Also the wastes contain impurities washed or pressed from the beets or unpurified sugar.

Investigations were made to determine the chemical composition of the wastes as sewage and its value as a fertilizing agent, to ascertain the amount of suspended matter which could be removed by fine screening and to find the amount which could be removed by sedimentation.

Results of a chemical analysis of a 24-hr. composite sample of roughly screened wastes indicated total solids at 2588 parts per million; of these 1891 parts per million, or 73 per cent, were suspended. Of the total solids 59 per cent were fixed or mineral matter, the remainder being organic or combustible. Of the suspended solids 64 per cent were fixed or mineral matter. The suspended fixed residue was found to consist chiefly of rock material insoluble in acids. The dissolved fixed residue was comprised chiefly of lime salt, but contained a trace of iron and considerable alumina. Oxygen consumed, as determined after a contact of 20 min. at 80 deg. C., was 198.5 parts per million, while the absolute oxygen consumed was estimated at ten times as much. The total organic nitrogen, determined as in fertilizer analysis, was found to be 7.14 parts per million. The total nitrogen was found to be about 13.15 parts per million. Reported as SO_3 sulphates were present to the extent of 50.6 parts per million, or about 930 lb. per 24 hr. discharge of wastes. Of this amount 370 lb. would be sulphur, on which the action of various species of bacteria may produce hydrogen sulphide, the gas which is mainly responsible for the disagreeable odors arising from the decomposing wastes in the lagoons at the factory. Since these sulphates are mainly in solution and are not contained in the suspended matters, it would appear that the liquid wastes must be kept fresh until finally disposed of by filtration or irrigation, according to the report.



GENERAL PLAN OF ANAHEIM SCREEN HOUSE AND FILTER BEDS

Comparing the composition of the sugar factory wastes and certain city sewage, it is noted that as respects total solids, suspended matters and organic matter, sugar waste is several times stronger than ordinary city sewage and stronger than the most concentrated sewages of English cities. As regards dissolved matters and potash content, the sugar wastes have about the same composition as a rather strong sewage. The nitrogen and chlorine contents are decidedly less than those of even weak sewages.

From all available records and data the amount of water used daily was about 2,275,000 gal., practically all of which left the factory as waste. On this basis the daily amount of wet screenings from 40-mesh screens would be 76,000 lb., or 46.6 cu. yd. The capacity of the plant was determined on this basis and subsequent observations proved it to be very close.

SEDIMENTATION AND SCREENING EXPERIMENTS

Sedimentation experiments on the rate and efficiency of subsidence of the wastes were made with the use of Imhoff graduates of 1000 cu. cm. capacity and showed that the coarser suspended matter settled very rapidly and that after 15 min. subsidence there was no perceptible increase in the volume of deposits. The moisture content of this sludge was probably about 95 per cent.

Two sizes of screens were employed, 40 meshes and 100 meshes per linear inch. The 40-mesh screen removed wet material equivalent to 76,000 lb., or about 46.6 cu. yd. per day. The proportions removable by the 40 and 100-mesh screens were 11.3 and 14 per cent respectively of the total dry weight of suspended solids in the wastes.

On the basis of the experiments conducted it seemed that a screen of the Weand type would remove 11.3 per cent of the total dry weight of suspended matters. The screenings could be partially dried in a centrifuge which would reduce the moisture content to 75 per cent. On this basis two screens and three centrifugal driers would be required for the pre-treatment of the wastes if absolute duplication of plant were to be provided.

Another suggested method of preliminary treatment was by Imhoff tanks. This was found to be somewhat more efficient than would be the fine screen, and from the experiments conducted indicated that 20 per cent. of the total dry weight of suspended matters in the wastes could be removed. This is equivalent to 83.2 cu. yd. of wet sludge per day. A settling period of at least 1 hr. would have to be allowed and the digestion chamber would require a capacity of 161,000 cu. ft. Further, the report states that the required sludge capacity would be reduced more than 50 per cent if preliminary fine screening were given to the waste. While the combined efficiency of the screens and tanks would probably be only slightly greater than that of Imhoff tanks alone, the cost of construction would be much less, requiring a digestion chamber in this case of but 70,700 cu. ft.

After due consideration of various means of handling the wastes it was decided to use fine screening followed by sand filtration. The land surrounding the factory is part of an old wash of the Santa Ana River, and is a natural filter bed with gravel and sand extending from the surface downward to a great depth.

Construction was begun on May 15, 1913, and the plant finished with the exception of the screen on Aug. 15, when the sugar company's campaign opened.

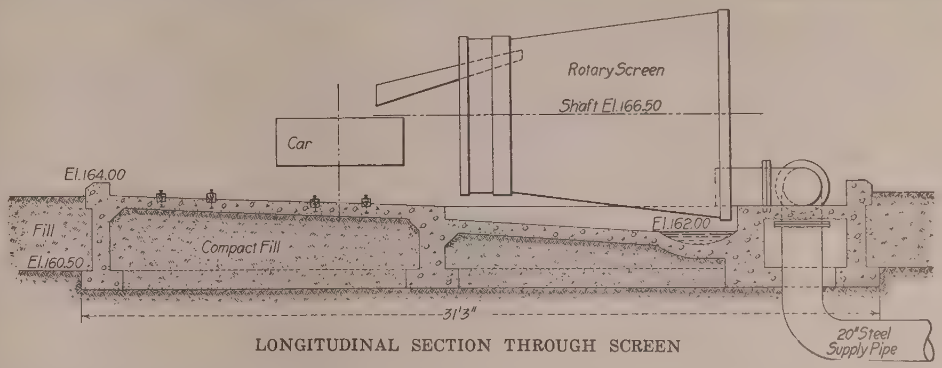
SAND FILTERS

The sand as found in the old wash is in strata of varying thickness, but the test holes showed a certain uniformity and demonstrated that the deeper the cut the coarser the material. An effective size of 0.10 mm was set as a proper minimum allowable size of sand and in nearly every case the sand at the required depth was much coarser. In general, samples taken from the surface to 12 in. down showed an effective size of 0.04 mm, those 12 to 24 in. down, 0.16 mm, and those from 24 to 48 in. down, 0.18 mm. Judging from experience with discharging waste into the lagoon, it was estimated that the waste would sink away at a rate of about 6½ in. per day. From the experiments and experience elsewhere with this method of purification, it was estimated that 150,000 gal. of screened waste per day could be placed upon each acre, and as it was desired to flood the bed to a depth of about 4 in. in from twenty to forty minutes, the size of the bed would be one-half acre each.

As constructed there are thirty-six filter beds in four rows of nine each, covering an area 1200 x 950 ft. The beds are separated by banks, 10 ft. wide, about 5 ft. high and with 2:1 side slopes. Each bed is 100 x 200 ft. in area, with an additional 30-ft. allowance for banks.

SCREENS

All the wastes, with the exception of lime, are collected in a sump at the northeast corner of the main factory building. Here a 10-in. open-runner sewage pump forces it through 1500 ft. of 20 and 22-in. riveted steel pipe to the screen house at the northeast corner of the filter bed site.



LONGITUDINAL SECTION THROUGH SCREEN

This is the highest point and after passing through the screen the water flows by gravity to the beds.

Near the screenhouse there is a by-pass by which the unscreened wastes may be diverted to farms on the east for irrigation purposes. The frame screenhouse has reinforced-concrete foundations with walls 4 ft. high, which project 1 ft. above the fill. Provision is made for two Weand rotary screens of the Atlanta type, but only one has been installed. It is cylindrical, 10 ft. long, 8 ft. in diameter at the inlet end and 6 ft. at the outlet end. It is chain-driven at a speed of 10 r.p.m. by a 5-hp, 440-volt, three-phase, 50-cycle motor. The lower half of the inlet end is closed by a ¼-in. steel plate which has an opening for connection to the 18-in. riveted pipe. The water entering the screen passes quickly through and the remaining material is carried by worm plates to the outlet end, where buckets lift it and drop it into a chute, carrying it to a Koppel side dump car of 30-cu. ft. capacity.

VIEW OF ROTARY SCREEN

From the screens the track projects north in a straight line along the side of a compost bin. By means of a turntable and lateral platform, resting on the bulkhead and posts in the compost bin, it is possible to fill every portion of the excavation. As the water dries out the volume contracts. At no time has there been any offensive odor.

The floor under the screen is sloping and the liquid runs down through a circular channel, and thence to a sand sump. A 6-in. vitrified pipe line, fitted with an irrigation gate, was used to wash out the sand once or twice a day last year. From the sump the water runs through a channel, 3 ft. wide, and over a short crested weir into a pit, which is the head of the vitrified pipe gravity system leading to the filters.

DISTRIBUTING LINES

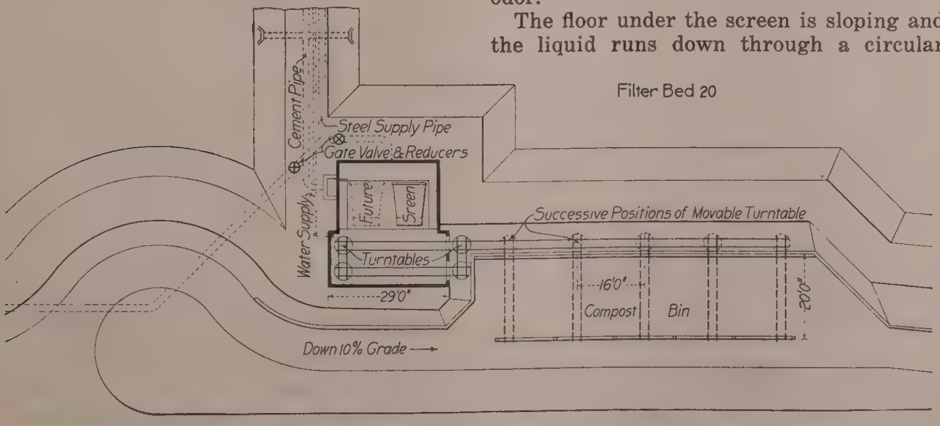
Two main distributing lines of 16-in. vitrified pipe are laid in the center of the embankment to serve two rows of filter beds. Opposite the center of each bed is a concrete box and vitrified outlet pipe through the bank. The ends of the outlet pipes are 21 ft. from the center of the supply line and terminate in a block of concrete which acts also as a support to the gate. All gates were of the 16-in. Kellar-Thomason Company quick-opening type and fitted with an appliance to hold the face tight against the seat when closed. An apron of concrete, 18 in. wide, with wing walls extends to the beginning of the wooden distribution flume.

Experience indicates that the success of the sand filters depends on the spreading of the liquid quickly and uniformly over the entire area. To accomplish this a redwood flume of the Brockton type was constructed in four sections, one of 25-ft. lengths and 3-ft. internal widths, and the next three 50 ft. long, varying in width from 2 ft. 4 in. to 1 ft. wide. At each point where there is a change in size, the first foot of the smaller section is hinged to regulate the flow of water. Circular aprons with deflectors were also installed at these points and at the end to prevent erosion of the bed itself.

In practice the beds were dosed in rotation for forty-five minutes, and in that time received 3 to 5 in. of water. The time of dosing came at periods twenty-four hours apart.

According to reports the plant has been entirely successful and when the sugar-making campaign of 1913 closed on Nov. 21, there had not been a single complaint by residents in the vicinity.

All laboratory studies and the preliminary investigation were made under the direction of Prof. Charles Gilman Hyde, of the University of California, and all figures and quantities noted above are taken from his report to Sloan & Robson, consulting engineers, San Francisco. R. E. Robson was in direct charge of construction and erection work from the beginning. The drawings for the plant were made in the office of the consulting and supervising engineers.



PLAN SHOWING ARRANGEMENT OF COMPOST BIN AND SCREEN HOUSE

AN ALL-STEEL CABOOSE has been built and placed in service by the Pennsylvania Railroad. The car is experimental and is being tried out on various divisions.

Economical Diameters of Pipes

Making the Size at Any Point Such a Function of the Elevation of That Point That the Amount of Metal Shall Be a Minimum

By E. W. RETTGER
Assistant Professor of Applied Mechanics, College of Civil Engineering, Cornell University, Ithaca, N. Y.

UNDER the heading "Designing Steel Pipe for Minimum Weight of Metal Consistent with Safety," E. R. Bowen described the Jawbone inverted siphon of the Los Angeles Aqueduct in the Engineering Record of Dec. 20, 1913, page 682. This inverted siphon is 7096 ft. long and its capacity is 430 sec.-ft. Its lowest point is 850 ft. below the hydraulic gradient. As the pipe goes down into the valley its thickness must necessarily increase, on account of the increasing head. Especially is this true if the pipe has the same diameter throughout. For the same head the thickness of the pipe is proportional to the radius. Considerable metal can be saved, therefore, by decreasing the diameter of the pipe as it goes down. The loss of head due to friction is increased, however, by decreasing the diameter. If the allowable loss of head is given, some one pipe will contain less metal than any other pipe that can be used. In the case of the Jawbone inverted siphon the loss of head due to friction was restricted to 26 ft. The pipe was so designed as to contain the minimum amount of metal, subject to the condition that its capacity should be 430 sec.-ft. The graphical solution of the problem given by E. A. Bayley seems to me to require a great deal of labor, and suggests a problem, general in nature, that might be of interest to hydraulic engineers.

The problem may be stated as follows: A pipe line is to be installed. Some parts of the line are considerably higher than other parts, due to topographical irregularities or to the high head used. We are given (1) the length of the pipe under consideration, which may be the whole length of the pipe or any part of it; (2) the capacity of the pipe, Q; (3) the static head of every part of the pipe under consideration, or what amounts to the same thing, the static head of some one point and the side elevation of the length under consideration, and (4) the allowable loss of head due to friction in the pipe under consideration. It is required to find what algebraic function of the elevation of any point the diameter of the pipe is for that point, so that the amount of metal in the pipe under consideration shall be a minimum.

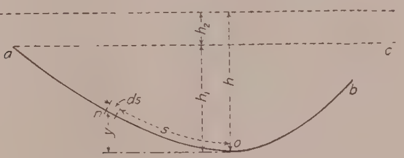


FIG. 1

In Fig. 1 suppose aob is the line under consideration. The lowest point o is h_1 feet below the level ac. The static head above ac is h_2. The total head for the point o is then $h_1 + h_2 = h$. Let Q = the quantity of water flowing through the pipe; h_f, the allowable loss of head between a and b due to friction, and l the total length of pipe aob. Q, h_f, l, h_1 and h_2 are given and must be considered as constants. We are required to find an algebraic relation between d, the diameter of the pipe at any point n, and y, the ordinate of that point, so that the required amount of metal in the pipe shall be a minimum.

SOLUTION

The required thickness of the pipe at any point is given by the equation

$$t = r(p - p_0)/T_1 = ad(h - y)$$

where a is a constant and h and y are given in the figure. The sectional area of the metal in the pipe is

$$A = \pi dt = \pi ad^2(h - y)$$

and the volume of the metal in the entire pipe from a to b is

$$V = \pi a \int_a^b d^2(h - y)\,ds \qquad (1)$$

Now the problem requires that this volume shall be a minimum. Since a is a constant, the integral

$$U = \int_a^b d^2(h - y)\,ds \qquad (2)$$

must be a minimum.

The volume of the metal in the pipe, however, is subject to the condition that the total loss of head due to friction shall not exceed a fixed amount h_f. We must, therefore, obtain an expression giving us the loss of head due to friction in this pipe of variable cross-section. The friction per 1-ft. length in a pipe may be given by the expression cv^n/d^m, where c, n and m are constants depending upon the kind of pipe used. (See "Transactions" of the American Society of Civil Engineers, Vol. LI (1903), page 308, and also the "Cornell Civil Engineer" of May, 1910.) For riveted steel pipes $cv^n/d^m = 0.00050v^2/d^{1.25}$. For cast-iron pipe $cv^n/d^m = 0.00038v^{1.86}/d^{1.25}$. The total loss of head, therefore, is

$$h_f = \int_a^b (cv^n/d^m)\,ds$$

or since $Q = Fv = \pi d^2 v/4$ and, therefore, $v = 4Q/\pi d^2$,

$$h_f = c(4Q/\pi)^n \int_a^b \frac{ds}{d^{2n+m}} = \int_a^b \frac{k}{d^p}\,ds \qquad (3)$$

where $k = c(4Q/\pi)^n$ and $p = 2n + m$.

The problem may now be stated as follows: Required to find d as a function of y such that the integral

$$U = \int_a^b d^2(h - y)\,ds$$

shall be a minimum, and that at the same time the integral

$$\int_a^b \frac{k}{d^p}\,ds$$

will take the required definite value of h_f.

The problem as now stated is a problem in the calculus of variation. Let

$$U = \int_a^b F\,ds$$

where $F = d^2(h - y)$, and let

$$h_f = \int_a^b F_1\,ds$$

where $F_1 = k/d^p$. Then, according to the calculus of variation, the required value of d as a function of y must make the integral

$$J = \int_a^b (F + \lambda F_1)\,ds$$

a minimum, and, therefore, must satisfy the differential equation

$$\frac{\delta F}{\delta d} + \lambda \frac{\delta F_1}{\delta d} = 0$$

where λ is a constant to be determined. If the values of F and F_1 are substituted and the partial differentiation is carried out we have

$$2d(h - y) - \lambda pk/d^{p+1} = 0$$

or, solving for d,

$$d^{p+2} = \lambda pk/2(h - y) \qquad (4)$$

where $p = 2n + m$, $k = c(4Q/\pi)^n$ and λ is a constant to be determined. To determine the constant λ we will make use of the fact that d must satisfy the condition

$$\int_a^b \frac{k}{d^p}\,ds = h_f \qquad (5)$$

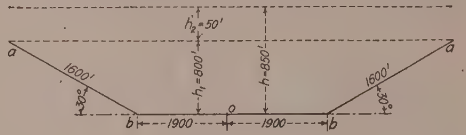


FIG. 2

If we substitute the value of d as found from (4) into (5) we obtain

k

$$h_f = \frac{k}{\lambda^r (pk/2)^r} \int_a^b (h - y)^r ds$$

where $r = p/(p + 2)$. Solving for λ,

$$\lambda^r = \frac{k}{h_f (pk/2)^r} \int_a^b (h - y)^r ds$$

$$= D \int_a^b (h - y)^r ds \qquad (6)$$

Equation (6) enables us to determine λ. The value thus determined must be substituted in equation (4),

$$d^{p+2} = \lambda pk/2(h - y) = G/(h - y) \qquad (4)$$

and we have a comparatively simple equation which will give us the diameter d for any ordinate y of the pipe line under consideration.

The determination of λ requires the evaluation of the integral

$$\int_a^b (h - y)^r ds$$

Now the ordinates y of the pipe line are known since the side elevation is known. We may, therefore, consider y as a function of s. When the line (or any part of it) approximates a simple known curve y may be expressed in terms of s. The integration may then be performed.

As a rule, in practice, the line of the pipe does not approximate a simple curve. We may then proceed as follows. Divide the pipe (or any part of it) into a number of equal parts each of length Δs. Equation (6) may now be written

$$\lambda^r = D.\,\Delta s.\,\Sigma(h - y)^r \qquad (7)$$

Now determine the value of $(h - y)^r$ for the middle ordinate of each division and add these values for all the divisions, that is, find $\Sigma(h - y)^r$.

RIVETED STEEL PIPE

The equations (4) and (6) will now be simplified for the case of riveted steel pipes. For this case $cv^n/d^m = 0.00050v^2/d^{1.25}$. Therefore, $n = 2$, $m = 1.25$, $c = 0.00050$, $p = 2n + m = 5.25$, $r = p/(p + 2) = 0.724$. If these values be substituted in (4) and (6) they take the form

$$d^{7.25} = 0.00213Q^2\lambda/(h - y) \qquad \text{(A)}$$

and

$$\lambda^{0.724} = \frac{0.0697Q^{0.552}}{h_f}\int_a^b (h - y)^{0.724} ds \qquad \text{(B)}$$

In a particular case Q and h_f are known. Having found the constant λ by means of equation (B), equation (A) gives us a simple relation between d and y.

EXAMPLE

We will apply equations (A) and (B) to a particular case. The article referred to does not give us sufficient detail to enable us to use that line. We will use, however, the data given for the Jawbone inverted siphon as far as possible. Let $Q = 430$ sec.-ft., $h_f = 26$ ft., $l = 7000$ ft., and $h = 850$ ft. We do not know what h_2 is. Assume $h_2 = 50$ ft.

For simplicity assume the side elevation to be symmetrical about a vertical through o. Fig. 2 gives the side elevation. Equation (B) now becomes

$$\lambda^{0.724} = 0.0762 \times 2 \int_o^a (h - y)^{0.724} ds$$

or, since $y = 0$ from o to b, and $y = s/2$ from b to a,

$$\lambda^{0.724} = 0.1524 \left[\int_o^{1900} (850)^{0.724} ds + \int_o^{1600} (850 - s/2)^{0.724} ds \right]$$

Evaluating these simple integrals, we find $\lambda = 3,782,200$. Substituting this value of λ in equation (A) we obtain

$$d^{7.25} = 1,490,200,000/(h - y)$$
$$= G/(h - y) \qquad \text{(C)}$$

Equation (C) enables us to find the diameter d for any ordinate y. For the lowest point o, $y = 0$ and $d = 7.45$ ft. as compared to 7.50 ft. given by Mr. Bowen. For the point a, for which $y = 800$ ($h_2 = 50$), we find $d = 10.7$ ft. Had we assumed a larger value for h_2, say 100 ft.—that is, $y = 750$ ft. for the point a—the value of G in equation (C) would not have changed very much and the value for d at the lowest point o would have been about the same. For the point a, however, we would have had $d = 9.7$ ft. Mr. Bowen states that the diameters in the case of the Jawbone siphon range from 7.5 to 10 ft. We thus see that the results obtained by means of the formulæ (A) and (B) agree well with those actually used.

The equations (A) and (B) are quite general for riveted steel pipes and may be considered as general formulæ. They require comparatively little labor. If the side elevation is given the constant λ can be determined by (B). Formula (A) then becomes very simple, giving us a relation between the diameter and the elevation of any point of the line under consideration.

Lining Walnut Hill Reservoir at Omaha

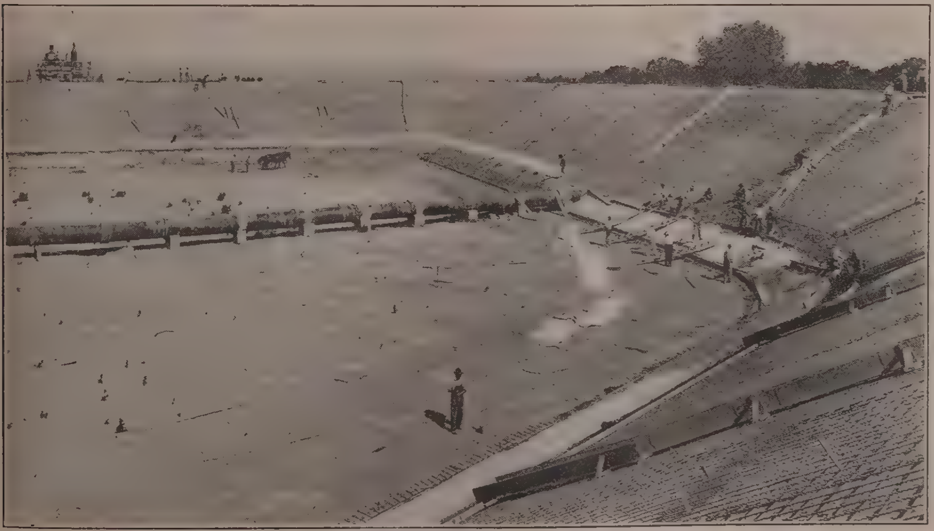
Desire to Eliminate Leakage Led to 6-Inch Shell of Concrete Reinforced to Make It Stand at the Corners Like a Dish

EXTRAORDINARY precautions against leakage were taken in constructing the Walnut Hill 11,000,000-gal. reservoir of the Metropolitan Water District of the city of Omaha. Consolidation of the embankment in 6-in. layers was followed by lining the bottom and inner slopes with 6 in. of concrete, reinforced in two directions for temperature stresses. Additional steel was placed in the slope corners for tank pressure, so that the lining will retain its shape like a dish independent of the earth behind it. To obviate using a dry mixture the concrete was laid on the slopes in horizontal sections 5 ft. wide, extending all the way around the reservoir. One strip was completed each day, thus practically making each strip of one pouring.

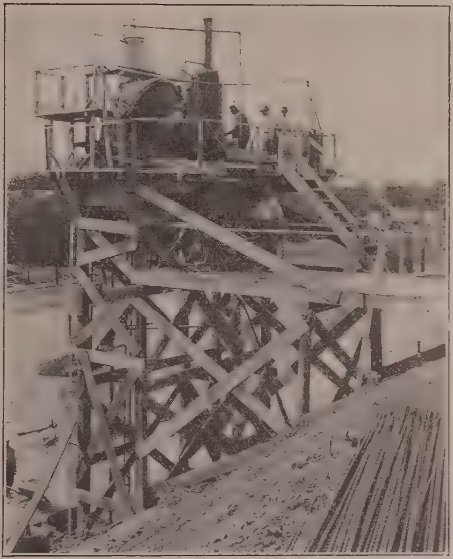
The object of the new reservoir is to increase by 100 per cent the distribution storage near town. As the water consumption in Omaha is about 18,000,000 gal. per day, there is now usually something over a day's supply at close range for immediate and emergency use. This reservoir and the two existing ones to the north simply float on the direct low-service system, which is fed from Florence, 6 mi. away. There are two independent 36-in. connections serving the inflow and outflow to the city mains. These are connected with a gate well located in the embankment between the two old basins. A 24-in. pipe connects this gate well with the new reservoir, upon which the inflow and outflow into the new basin may be regulated as desired. In this gate well, also, gates are connected with two pipe lines which serve to regulate the water in the two north basins.

ELIMINATION OF LEAKS

Especial care was taken in the construction of the new basin to eliminate leaks, in consequence of considerable trouble experienced in the two adjoining basins to the north. In these reservoirs settlement and water seeking out and following gopher holes finally required extensive repairs, which were accomplished by grouting the earth embankments under the concrete lining and calking the joints wherever necessary. These basins are now tight.



CONCRETING WALNUT HILL RESERVOIR SLOPES IN HORIZONTAL STRIPS



ELEVATED CONCRETE PLANT FOR LINING

In shape the new basin is a rectangle about 227 ft. wide by 359 ft. long at the top of the slope, with one corner cut off to obviate an extensive fill. The top of the embankment is 20 ft. wide, the inside slope is 1¾ : 1 and the outside slope 1½ : 1. The depth of the completed basin from the floor to the top of the coping is 21 ft. The 6-in. paving ends at the top at a curb 12 in. wide and 12 ft. deep. Steel bars extend upward into the curb and downward into the 15-ft. footing slab at the base of the slope. The reinforcing consists of ½-in. twisted steel bars spaced on 8-in. centers, equivalent to 0.5 instead of the 0.4 per cent usually allowed for temperature stresses. The spacing of the steel in the corners was worked out by a curve, the minimum required for the small diameter at the bottom being compensated for at the greater head.

HOISTING ENGINE ASSISTS TEAMS

Preparation on the site consisted in grubbing all trees and brush and stripping 10,000 cu. yd. of top loam. Then 16,000 cu. yd. were excavated from the reservoir and placed in the embankment and 36,000 more were added from the borrow pit near at hand. The teams had an average haul of 400 ft. and a lift of 30 ft. Toward the end of operation three wagons were hooked together and a cable from the drum of a hoisting machine was used to assist the teams up the 15-per cent incline.

Sprinkling and rolling, strictly in 6-in. layers, were carried on with a 10-ton Buffalo Pitts and a 14-ton Monarch steam roller. Due to this procedure the shrinkage over the borrow-pit measurements amounted to 21 per cent. The material was of a mixture of sandy loam and clay.

Removing the material stripped from the embankments previous to placing the concrete lining was accomplished by men with wheelbarrows to each of which was attached a rope passing through a sheave in a three-legged derrick on the top of the embankment. A horse supplied the motive power.

In point of order the slope lining was

placed first. Then a slab 15 ft. wide was laid on the floor of the reservoir at the base or foot of the slope, and finally the remaining bottom slabs completing the remainder of the floor were deposited. Two No. 11 Smith mixers mounted on elevated platforms, 38 ft. above the ground, were set up on opposite sides of the embankment, each mixer being used for half a day. Wooden guides for the charging skip used on a previous job were replaced by steel guides. Having the skip drop to the natural ground saved hauling up an incline; in fact, the incline used in placing the embankment was removed.

The standard engine was sufficiently powerful to operate the drum full and hoist a batch—1½ cu. ft. of Dewey Portland cement, 4 cu. ft. of sand and 6 cu. ft. of stone—for two-thirds of the distance. When the skip was about half way up the operator threw in the power tilt clutch. By the time the loaded skip reached the top the drum was emptied. The average time taken to hoist the skip to a discharging position was 30 sec. A complete round trip took 70 sec. In a 9½-hr. day 418 batches, equivalent to 142 cu. yd., were placed.

WATERPROOFING

From the mixers the concrete was distributed around the top of the embankment in buggies to chutes provided with flexible sections near the lower end. For the slabs in the bottom, concrete was chuted down the slope opposite each mixer to a small hopper from which the buggies were loaded.

From 5 to 6 lb. of Trus-Con waterproofing paste were used for each cubic yard of concrete mixed, this paste being dissolved in the water supplied to the concrete mixer. The concrete slabs and floor of the new basin received two coats of cement grout, which was applied from a barrel mounted on an elevated platform at the top of the embankment. Wheels which supported this elevated platform ran over one plank placed on the coping and another on the top of the embankment. A hose from the barrel distributed the grout and a street broom was used to scrub it in.

Laying and spacing the steel up the slopes was facilitated by 2 x 4-in. templates in which dowels were inserted at 8-in. intervals. After wiring all of the horizontal rods to every third inclined rod, the dowels were removed and the templates pulled out from the top.

Lamoreaux Brothers, the grading contractors, received 29.4 cents per cubic yard. This unit price included grubbing and stripping, but did not include the cost of sprinkling and rolling the embankment.

Plans, specifications and the execution by day labor of all concrete work and rolling of embankments were carried out under the general direction of R. B. Howell, general manager of the Metropolitan Water District, for which George T. Prince is chief engineer. H. V. Knouse is resident engineer and H. S. Nixon is office engineer.

Chicago, Burlington & Quincy Concrete Pile Trestles

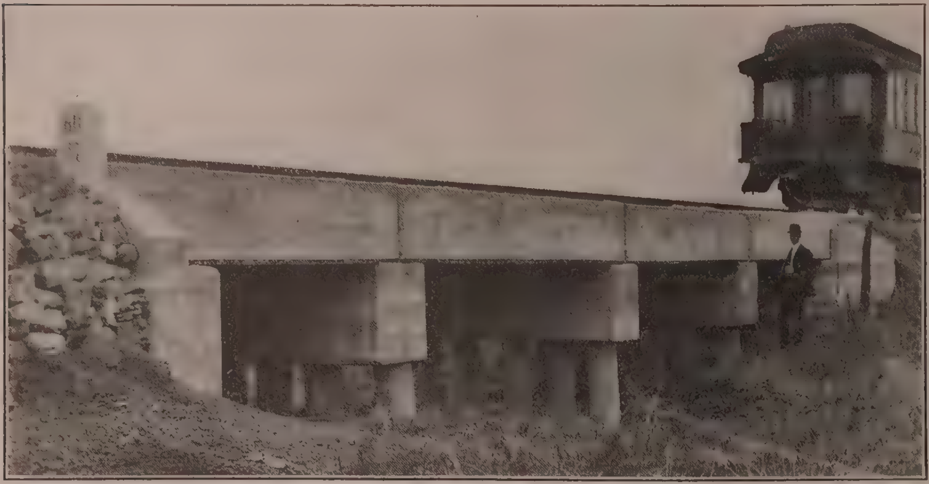
Dimensions and Other Features of Standard for Single Track Adopted to Eliminate Timber and Exposed Steel

THE main dimensions and other features of the Illinois Central standard reinforced-concrete pile trestle were set forth in the Engineering Record of Oct. 3, page 378. A very similar standard for single track is in use by the Chicago, Burlington & Quincy Railroad. The track is laid in stone ballast on solid reinforced-concrete single-track pile trestles and floor slabs, supported on transverse bents of round piles cast before driving and connected by cast-in-place caps. This allows a large proportion of the concrete to be cast in the yards, facilitates rapidity of erection and entirely eliminates the use of timber and exposed steel for pile trestles.

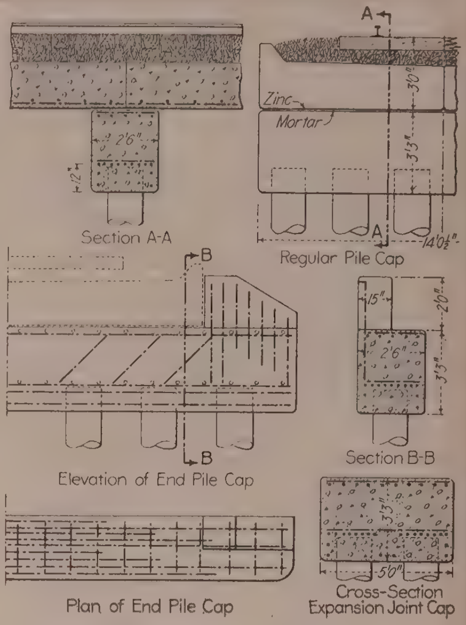
The straight cylindrical piles, which are 15 in. in diameter, are reinforced by a longitudinal spiral web of ½-in. mesh No. 16 wire and eight ½-in. corrugated longitudinal bars. The points may or may not be tapered to a diameter of 4 in. in a length of 18 in.

INTERMEDIATE AND END BENTS

Intermediate bents, which are spaced 14, 15 or 16 ft. on centers, are single rows of piles with caps 2½ ft. wide. They support the fixed ends of the floor slabs. Every sixth bent has a double row of piles with caps 5 ft. wide to allow for temperature movements at the expansion joint between adjacent floor slabs. For the end bents of the trestle the piles are spaced farther apart; their longer caps overhang the end piles and have special shoulders projecting above the upper surface to form guides to engage the edges of the floor slabs and prevent them from being displaced transversely to the bridge axis.



REINFORCED-CONCRETE SINGLE-TRACK PILE TRESTLE WITH 16-FT. SPANS



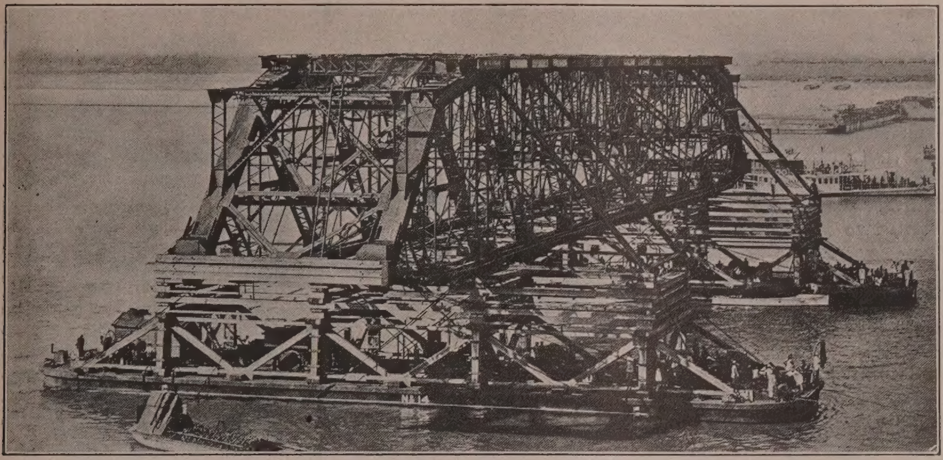
CONCRETE TRESTLE PILE CAP AND SLAB

In all spans the slabs are made in longitudinal halves with a uniform width of 7 ft., and are provided at each end with a stirrup on the center line projecting just above the upper surface to receive lifting tackles. The upper surfaces of the slabs are pitched 1 in. transversely from the center line of the tracks for drainage, and the outer edge is provided with a reinforced parapet from 6 to 8 in. high to retain the broken-stone ballast, which has a standard minimum thickness of 6 in. under the ties. The minimum thicknesses of the slabs are 1 ft. 9 in., 1 ft. 10 in., and 1 ft. 11 in. for the 14, 15 and 16-ft. spans respectively. The floor slabs have sharp corners, but the pile caps have rounded corners. The slabs are seated on zinc bearing plates, 1/32 in. thick, bedded in cement mortar on the tops of the pile caps. All concrete is made 1:2:4, requiring 1¾ bbl. of cement per cubic yard of concrete. The slabs are waterproofed with 10 lb. of Ceresit per cubic yard of concrete.

The trestles are designed and constructed under the direction of the engineering department, of which C. E. Calvert is chief engineer, and C. H. Cartledge, engineer of bridges.

Plank Road Costs

IN connection with the construction of the Thirty-ninth Street conduit for the Sanitary District of Chicago it was necessary to provide a temporary outlet for abutting property owners over 618 ft. of soft black muck lying over clay. The road was constructed of hard maple 2 x 8-in. planks, 8 ft. long, laid on three lines of 3 x 6-in. mud sills or stringers. The cost of teams to distribute the material along the work is included in the price for the lumber—15,328 ft. b.m. at $18.50 per thousand. The labor on the road was performed by one carpenter for 34 hr. at 60 cents, and one carpenter's helper for 38 hr. at 37½ cents. For other laborers there were required 265 man-hours at 31½ cents. This amounts to 19 cents per linear foot for laying, or $7.73 per 1000 ft. b.m. The total cost per linear foot was 65 cents. The road was constructed under H. R. Abbott, resident engineer, and Langdon Pearse, assistant engineer, reporting to George M. Wisner, chief engineer.



SHIFTING 1000-TON 345-FT. FALSEWORK SPAN ON PONTOONS

Bridge over Lower Ganges River in India

Railroad and Highway Structure 5900 Feet Long, with Deep Foundations and River Channel Protection, Being Built at a Cost of $16,000,000

By FREDERICK C. COLEMAN
Newcastle-on-Tyne, England

THE most costly engineering construction now being executed in India is the double-track railroad and highway bridge 5900 ft. long which crosses the Ganges River about 118 mi. from Calcutta with fifteen 359-ft. spans supported on dredged caisson foundations sunk 160 ft. below low-water level. Important features of the work include unusual details of the substructure and superstructure, the building, dredging and concreting of the deep pier foundations, the preliminary assembling in the shops of the main spans and their erection at the site on falsework bents and falsework spans, the construction of the $3,700,000 protection works on the river banks and the employment there of more than 24,000 men at once.

SUBSTRUCTURE

The caisson foundations of the sixteen main piers are sunk to a depth of 190 ft. below high flood level and are said to be the deepest of their kind in the world. The cutting edge, 140 ft. below sea level and 160 ft. below lowest water level, is sunk through sand and stiff clay and rests in sand 60 ft. below the deepest recorded bend scour limit of this river. The load on the sand is about 9 tons per square foot, allowing for buoyancy and not for friction.

The 61 x 35-ft. caisson has a steel cutting edge 15 ft. 7 in. high, is filled with concrete and weighs 140 tons. It is provided with two 18½-ft. dredging wells, and for deep-water foundations its walls are extended up to a maximum height of 65 ft. with 7-ft. courses of steel plates. The wells are also lined with steel plates to insure water-tightness and increase the strength. The caissons are filled with mass concrete and above their tops the walls are carried up to above low-water level with 6-ton concrete blocks. After the sinking is completed the well holes are closed by top and bottom plugs of concrete 18 ft. thick and the space between them is filled with sand.

Some of the caissons were erected on the river bottom in the dry season and floated to position on rising water, and some were launched from ship ways, but most of them were erected on wooden pontoons and launched by sinking the pontoons under them. Special provisions were made to insure the necessary sinking of each foundation in one season. Generally the cutting edges were floated to position, inclosed by floating overhead staging equipped with electric cranes and concrete mixers. The dredging wells were provided with water-tight bottoms and the caissons were gradually sunk as the sides were built up and concreted. When sunk nearly to river bed the false bottoms were opened and the cutting edges quickly landed on the sand bags previously spread over the bottom of the river to prevent scour. The sinking was accomplished by dredges of 100 cu. ft. capacity. Each caisson contained an average of 15,300 tons of masonry and 355 tons of steelwork.

PIERS

Above low-water level the top of the dredging well is capped with a reinforced-concrete slab 6 ft. thick supporting the pier. The piers have semicircular ends and vertical sides. They are built of brick laid in cement, faced with concrete blocks and covered with a reinforced-concrete cap 6½ ft. deep, in which are embedded steel grillages to receive the superstructure and afford bearing for the temporary erection spans.

The 45½ x 27-ft. rectangular U-shaped abutment piers have reinforced-concrete footings 11 ft. deep supporting mass concrete faced with concrete blocks and capped with a 3-ft. slab of reinforced-concrete in which steel grillages are embedded.

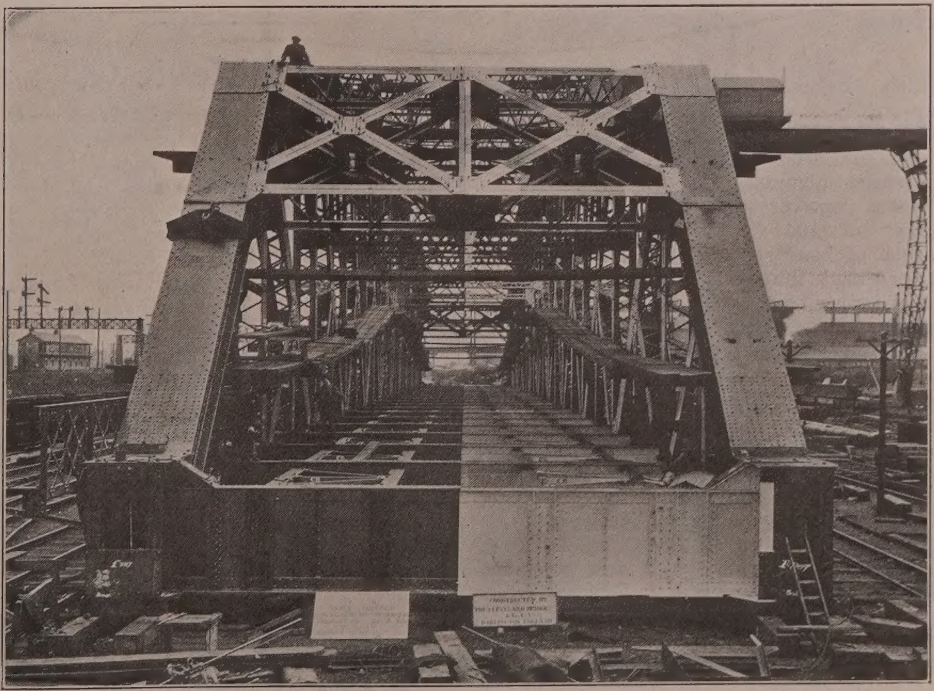
The estimated cost of the piers and abutments is about $3,000,000.

SUPERSTRUCTURE

There are three 75-ft. land spans and fifteen main spans. Their lengths are 359 ft. on centers of piers and 345 ft. 1½ in. on centers of bearings. The main trusses are 52 ft. deep over all and 32 ft. apart on centers. They have cast-steel rocker bearings 5 ft. 7 in. high, which, at the expansion ends, provide for longitudinal movements of 3¼ in. The floorbeams are located at panel points 15 ft. 8¼ in. apart. The main truss members are built up of plates and angles latticed with channels. The largest chord section is 42 ft. long and weighs 16 tons. The substruts and diagonals have bulb flanged lattices with steel tubes flattened at the ends. The footwalk between the tracks has a floor of 5/16-in. buckle plates. In order to reduce the weight of the piers the spans are carried on steel towers about 40 ft. high.

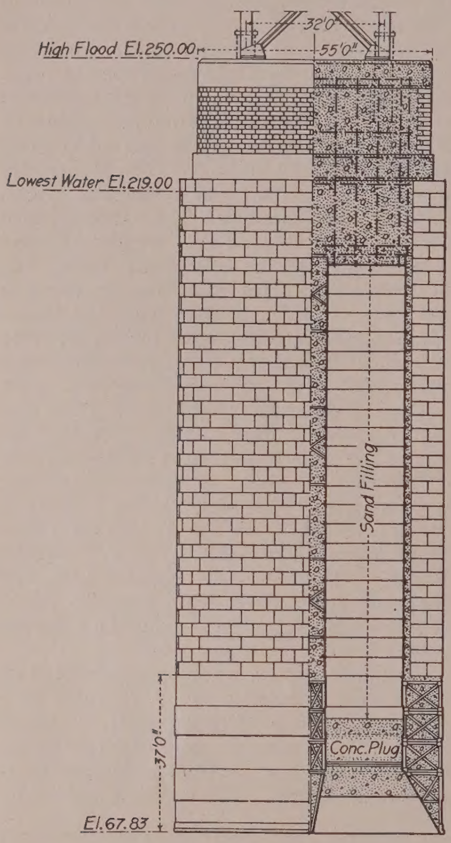
Each main span weighs about 1216 tons and was erected at the bridge shop in England. The superstructure is built according to the British standard specifications and was designed by Rendel, Palmer & Tritton, consulting engineers of the India office. Nine spans were built by the Cleveland Bridge & Engineering Company, Ltd., and six by Braithwaite & Kirk, Ltd. To facilitate erection each span is painted a different color.

In shallow water the spans are erected on timber-pile falsework. In deep water they are erected on a 1000-ton steel falsework span shifted from pier to pier on two pontoons provided with timber falsework of adjustable height. The erection is done by



ONE OF MAIN SPANS TEMPORARILY ERECTED IN CONTRACTOR'S YARD a gantry traveler running on tracks supported by the erection span or on top of the falsework and by small gantry cranes on the top chords. In each span there are about 60,000 field rivets driven by pneumatic and hydraulic machines. The falsework contains about 4000 tons of American pine timber and 40 tons of fittings. It is estimated that the steelwork of each span will cost about $200,000, erected and painted.

At the site the river banks are protected on each side from erosion by a guard bank which extends 3000 ft. upstream and 1000 ft. downstream from the bridge and has the ends curved away from the river. The banks are about 18 ft. above the highest flood level and are protected on the river slopes by stone pavement from 2 to 3½ ft. thick. Beyond the toe of the slope is an apron 4½ ft. thick and 150 ft. wide. It is expected that as the outer edge of this apron is undermined the stone will gradually settle down to a uniform continuation of the bank's slope, protecting the river bed to a depth of 100 ft., the maximum known depth of bend scour. Upstream from the guard bank the semi-permanent clay banks of the river have been protected with paved aprons 4000 ft. long to maintain a straight approach to the bridge. The protection work involved more than 23,000,000 cu. ft. of paving stone and 38,000,000 cu. ft. of earthwork in the bank, besides a reserve of 2,800,000 cu. ft. of stone kept ready for use. The estimated cost of the protection work is about $3,700,000.



STEEL AND CONCRETE PIER CAISSON

Stone for the paving and concreting is transported 234 mi. by train or 134 mi. by boat. Building sand is delivered by train, and cement is imported from England. The concrete blocks are cast on both sides of the river in yards, each equipped with stone crushers, concrete mixers and a 10-ton traveling crane of 53-ft. span. One of the yards has a special molding shed and overhead trolley gantry for making and handling the face blocks. About 40,000 blocks have been cast in these yards.

Power and light are supplied from two power houses, one of 1125 kw capacity on each bank. The 3300-volt alternating current is transformed down to 440 volts for the machinery and 110 volts for light. The principal plant includes two erection travelers, two 10-ton traveling cranes of 53-ft. span, two 20-ton steam traveling jib cranes for unloading steel work, three 10-ton floating derricks with 80-ft. booms, five stationary and traveling 10-ton hand derricks, ten 15-ton overhead cranes for pier work, and numerous boats, locomotives and cars. At one time 24,400 men were employed at the site. It is expected that the bridge will be in service in 1915.

Force Clause in Wisconsin Highway Law Unconstitutional

By a decision of the Wisconsin Supreme Court Oct. 6, the "force" clause in the State highway law was declared unconstitutional. According to this clause if private subscriptions were made amounting to one-sixth of the cost of an improvement, the town, county and State must provide the remainder. It was held that this clause delegated to the group of freeholders making the contribution the legislative power of determining the amount of taxes to be levied, and that such delegation of power was unconstitutional. It is reported that proposed State highway construction costing more than $750,000 may be affected, although the opinion prevails in many counties that much of the money needed will still be raised voluntarily.

Unfair advantage had been taken of the law in some cases. For instance, in the southeastern part of the State a small group of real-estate owners made the necessary contribution to get a concrete road built by their property, although another main concrete road, parallel and less than 1 mi. away, carried practically all of the traffic. This was done when the county was straining its resources to complete the main road to its county limits.

Book Reviews

The report of progress of stream measurements in Canada for the year of 1912 contains 459 6½ x 9¾-in. pages, together with numerous inserted plates and photographs. The volume was prepared by P. M. Sauder, chief hydrographer, under the direction of F. H. Peters, C. E., commissioner of irrigation. (Ottawa, Canada, Department of the Interior.)

Scales for Ascertaining the Dimensions of Pipes, Drains and Sewers is the title of a 16-page, 5 x 7¼-in. booklet written by C. E. Housden, late superintending engineer, Public Works Department, India, and sanitary engineer to the Governments of Burma, Eastern Bengal and Assam. The diagrams at the end of the book are so constructed that as soon as $(L/H)F^2$ or $(L/H)G^2$ are determined, where L = length of pipe; H, head lost in friction; F, discharge in second feet, and G, discharge in gallons per minute, the diameter of the conduit can be read. For $n = 0.012$ in the Kutter formula the values are given in figures, but for $n = 0.010$, 0.011, 0.013, 0.014, 0.025, incrusted pipes, canals in earth newly dressed and ordinary earth canals, deductions or additions to the given value must be made. These figures are read by a movable scale on inclined lines. The booklet appears to be of a useful nature and should be appreciated by engineers. (London, England, Longmans, Green & Company, $0.60 net.)

Statistics of the railways of the United States for the years 1900-1912 are given in Bulletin 66 issued by the Bureau of Railway Economics. The bulletin is a paper-covered pamphlet of seventy-five pages, giving tabulated data as to population and area, railway mileage, capital securities and dividends, revenues, expenses and taxes, employees and compensation, equipment, freight traffic and passenger traffic. (Washington, D. C., Bureau of Railway Economics.)

A pamphlet entitled "Standard Plans and Specifications" has been published by the Department of Water of San Diego, Cal. The text has been prepared by Herbert R. Fay, superintendent, and H. A. Whitney, hydraulic engineer. This information should be of considerable interest to municipal engineers, for it covers the city's requirements as to water mains, valves, hydrants, meters, trenches and other subjects in the daily routine of the waterworks superintendent.

"The Diaphragm Method for the Measurement of Water in Open Channels of Uniform Cross-Section" is the title of Bulletin 672 of the University of Wisconsin written by Carl Robert Weidner, C. E., instructor in hydraulic engineering. It contains 72 pages, 30 text illustrations and six inserted plates. The book is the result of a comprehensive research of the available foreign literature on the subject and offers much data of interest and value to hydraulic engineers. It is to be regretted, however, that only the older type of diaphragm has been shown and that later improvements of the method have not been mentioned. (See Engineering Record, Sept. 19, 1914, page 332). Of special interest is the description of the recording apparatus, which, however, has now been materially simplified by the remodeling of the screen. Of interest also is the comparison between this method and those employing current meters and chemical solutions. (Madison, Wis., Engineering Experiment Station, University of Wisconsin. 25 cents net.)

Elements of Electricity and Magnetism. By W. S. Franklin and Barry Macnutt. Cloth, 5½ x 8½ in.; 351 pages; 254 illustrations. New York, The Macmillan Company. $1.25 net.

This book is intended primarily for technical schools and colleges. Holding that it is essentially an extension of the science of mechanics, the purpose of the book is to develop the theory of electricity and magnetism from that point of view. The attempt is made throughout to bring practical applications to the mind of the student. The authors believe that "elementary science instruction must be made to touch upon the things of every day life if it is to be made effective."

The chapters are as follows: The Electric Current, Its Chemical Effect; Resistance and Electromotive Force; Magnetism of Iron; Magnetic Effect of the Electric Current; Induced Electromotive Force; Electric Momentum, Inductance; Electric Charge, the Condenser; Phenomena of Electrostatics; Electric Oscillations and Electric Waves; Electrical Measurements. There are appendices on terrestrial magnetism, on ship's magnetism and the compensation of the compass and on miscellaneous phenomena.

UNIT CONSTRUCTION COSTS. By E. Horton Jones. Cloth, 6 x 9 in.; 152 pages. New York, McGraw-Hill Book Company, Inc. $2.00 net.

(Reviewed by E. P. Goodrich, consulting engineer, New York City.)

A reprint of a part of the "Transactions" of the American Institute of Mining Engineers for the present year from pages 1497 to 1649, inclusive, has been prepared as a book giving costs and other pertinent data in reference to the construction of the new smelter of the Arizona Copper Company, Ltd., at Clifton, Arizona. The matter is divided into six chapters with the following captions: Unit costs, comparative costs, composite costs, wage scale, raw material prices, description of costs.

In the chapter on raw material prices are to be found nearly 150 reproductions of drawings, mostly of details of construction in connection with which the cost records can be more completely interpreted. No similar compilation of so comprehensive a nature is known, the work being applicable to excavation, concrete tanks, boilers, chimneys, etc., reverberatory and converting machinery, structural and mill work on shops, warehouse, office and laboratory buildings, power plant in minute detail, etc.

The cost items have been classified according to a plan somewhat like the decimal system used in library work, the classification in many cases being carried to four places in figures. Through the arrangement followed an engineer can determine the total distributed cost of each structure, and also of each kind of work on each of the structures. For example, the power house and plant contain over 100 items and again, under the subject of excavation, or of concrete, or of structural work, the costs of the power house are repeated.

Under the caption "Composite Costs," the square foot and cubic foot values for buildings are recapitulated. The costs of boilers per horse-power, and of machinery in capacity per ton, are given. With the detail wage and raw material scales and the costs of overhead included in the work, an engineer can form a remarkably accurate idea of what similar work should cost in that region and, except for material costs, what similar jobs should cost in any other part of the country.

The inclusion of nearly 100 pages of descriptive matter, divided in accordance with the decimal system used elsewhere, gives all the information which might be included in a book and makes this work unique as a reference book for designing and construction engineers and for contractors.

SYMMETRICAL MASONRY ARCHES. By Malverd A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute. Cloth, 6 x 9 in.; 245 pages. New York, John Wiley & Sons, Inc. $2.50.

(Reviewed by F. H. Constant, Professor of Civil Engineering, Princeton University, Princeton, N. J.)

The first edition of this work, published in 1906, was the outcome of the author's earlier and more general treatise on arches. An arch which is symmetrical in regard to the crown permits of a very material simplification of the working formulæ, and as such arches are most frequently met with in practice, the special treatment is well justified. The present second edition has been largely rewritten, the errors corrected, and when possible the demonstrations of the formulæ simplified. New matter has been added.

Chapter 1 covers the fundamental formulæ and leads up to the three equations of condition used in the solution of the fixed arch. Chapters 2 and 3 develop all of the working formulæ for the symmetrical arch fixed at the ends, including the effects of changes of temperature and axial thrust. Single vertical or horizontal unit loads alone are used, permitting maximum stresses to be found definitely. While many of the intermediate steps are given, the final equations are comparatively simple and lend themselves readily to the tabular form of solution. The important working formulæ are finally summarized at the close of chapter 2. Graphical representation of bending moments are also introduced from time to time to illustrate the subject. In chapter 3 the author also discusses the reliability of the elastic theory when applied to steel, stone, and plain or reinforced concrete ribs. The well known empirical formulæ used in American and European practice for the depth of the arch ring at the crown are compiled, and the size and stability of piers and abutments and the nature of the dead load described.

In chapter 4 two examples are worked out in detail, the first being a 60-ft. granite rib (which, however, is solved by the elastic theory), and the other a 50-ft. reinforced-concrete rib of the Thacher type. The computations are arranged in tabular form where they can be readily followed. The experienced computor would undoubtedly be able to reduce greatly the amount of this tabular work. Six entension plates in the rear of the book still further illustrate these examples, giving various equilibrium polygons, moment diagrams, geometrical data, and influence diagrams. The short descriptive chapter 5, shows various typical and well known arches. Appendix A contains 40 pages, giving in tabular form the data for over 500 arch bridges, including about 75 of the most recent plain and reinforced concrete arches.

Appendix B gives an interesting method by which an arch ring of a certain span, rise, crown, depth, and loading, for which all of the computations are at hand, may be changed in all of these respects and the new values of thrust and moments found directly from those of the first span with comparatively little labor. It is necessary, however, that the transformed arch conform to the original in having the vertical ordinates (y) of the rib axis and the ring thickness function ds / I vary in accordance with the same laws. To facilitate this work, tables of coefficients for twenty arches of different form, span length, and rise are given, from which new thrusts, end of moments, and end shears for the transformed arch may be found. The method is illustrated by the numerical example where the rise of a 100-ft. arch, conforming to type 16, is changed from 16.67 to 12.5 ft.

Appendix C gives formulæ for the symmetrical fixed arch when the origin of coordinates is at the crown. The formulæ are applied to the second example of chapter 4 by the tabular method. Appendix D gives a few of the formulæ for the unsymmetrical arch; and appendix E discusses some recent experimental results upon the internal temperature range in concrete bridges.

The book forms a valuable contribution to the engineering literature in this field, and in its revised form will be appreciated both in the class room and in the office of the practicing engineer.

Letters to the Editor

Resistance of Timber Joints

SIR: In a letter entitled "Resistance of Timber Joints" which appeared in your issue of Sept. 12, page 310, there is a discussion of the writer's description of some timber joint tests which appeared in your issue of Aug. 1, page 132.

In this letter the following unmodified sentences occur: "The article (referring to the writer's) contains some statements which are in error and omits some important facts. Their omission has apparently led to erroneous conclusions and is apt to mislead the reader in his judgment as to the practical value of the joints."

Lest the reader obtain from this statement the impression that such errors are numerical in their nature and that therefore the values of the results given are incorrect or that these erroneous statements are of such importance as to invalidate the results, the writer wishes here emphatically to indicate that these "errors" do not relate to the real substance in the writer's description. Reference is here made particularly to the fourth and sixth paragraphs in the letter. The letter makes no mention of any numerical errors and so far as the writer knows there are no such errors in the data nor in the results which he has given.

As to the "omission of some important facts," etc., the writer welcomes all data which are pertinent to the question, such as, for instance, the explanation of the cause for certain of the hardwood pins being slab-sided. But as far as the usefulness of the test results is concerned, the writer's indication that some of the pins in the large timber test specimens did not fit covers the fact as fully as the explanation for their misfit.

As the result of considerable intimate experience in the testing to failure of many kinds and qualities of structural materials, the writer, in this case, as usual, has restricted his conclusions to the limits of reasonable inference from the actual test data pertaining to these test specimens of workmanship as described. The writer did not state that better timber joints could not be fabricated, nor, least of all, did he intimate, nor mean to intimate, comparisons between the materials or workmanship on some of these test specimens and the actual materials or framing in the Panama-Pacific Exposition buildings, but his conclusions as applied to the character of specimens as described and actually tested are not erroneous. These conclusions simply state what is numerically represented in the average actual test results without any addition of opinion interpretation.

While joints of better workmanship and materials are entitled to more favorable consideration, their exact value, to be authoritative, must be determined by actual tests of representative specimens. The commercial use of a structural material or fabrication with a large factor of safety is not the equivalent of a life-size test of it to failure when its behavior under stress, its maximum resistance and its manner of failure are the questions at issue. It is rare that a forecasting opinion as to structural resistance closely agrees with the actual results of a full-size test when the material of the test specimen is unusual or its fabrication complex.

While the testing was officially done by members of the staff of the Civil Engineering Testing Laboratory of the University of California (in fact, a special micrometer was designed by the undersigned to determine the tensile stress developed in the joint bolts, the results of which determinations were not included in the description of the tests appearing in the Engineering Record), the Division of Works is surely entitled to its share of credit for the designing and preparation of the test specimens. Due acknowledgment was made in the original article.

Paragraph ten of the letter cites a comparison in strength between large and small joints in which lathe-turned pins were used. Two large joints of Type C had pins of red Australian iron bark. The small joints were B7 and B8, with Hawaiian Ohia pins. The average efficiency per linear inch of pin of these two large joints is reported as being 88 per cent of the efficiency of the small joints; this means an efficiency for the large joints of about 27.3 per cent, which may, of course, be increased by increasing the number of pins. But the efficiency would not increase in direct proportion to the increase in number of pins. The above citation upholds the writer's contention that the efficiency of large joints is less than that of small ones. It is of course true that the decrease in efficiency with increase in size of joint depends largely on the workmanship. The writer agrees that an efficiency of large joints equal to 60 per cent of the strength of small well-made ones does not hold for carefully fabricated large joints in which first-class materials are used. The test data under discussion, however, have clearly demonstrated the fact that one may expect for large timber joints of this type, where the wooden pins may be checked and do not fit well, an efficiency of only 60 per cent of that for well-made small joints of good materials, and that, therefore, for efficiency, good materials and, more particularly, good workmanship are of the first importance in the fabrication of this type of timber joint.

ARTHUR C. ALVAREZ,
Assistant Professor of Civil Engineering,
University of California.
Berkeley, Cal.

Paving Reservoir Slopes

SIR: The statement in the article on "Paving Reservoir Slopes" in the Engineering Record of Sept. 12, page 301, that "fine-grained stones are not satisfactory," may be misleading to readers unfamiliar with the conditions at Ashokan reservoir.

Bluestone and shale are the only kinds of stone available in the region where this work is being done, and it has been found that the finer-grained varieties tend to disintegrate more or less rapidly on exposure to the weather, even though apparently sound when first quarried. For this reason they are not permitted either in paving or for concrete aggregate.

The complete specification from which the statement in your article apparently was taken is as follows:

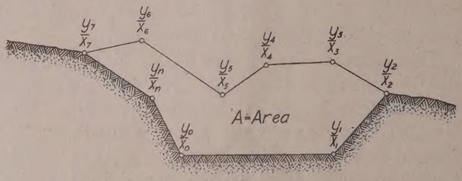
"None of the finer-grained bluestones or shales will be satisfactory for paving, nor any stones which soon 'reed,' or split into thin layers, on exposure to the weather."

ALFRED D. FLINN,
Deputy Chief Engineer, Board of Water Supply.
New York City.

Computing Cross-Sections

SIR: G. E. Trautwine's letter in your issue of Sept. 12, 1914, page 310, suggesting a method of computing areas of three-level sections, impels me to offer for your attention a general method applicable to a cross-section of any number of points, be their arrangement however irregular. The writer makes no claim to originating the formula, having merely adapted to the work of figuring cross-sections the formula proposed on page 160 of William G. Raymond's textbook of plane surveying. And Mr. Raymond's formula is merely an expression in formula form of the well-known method of computing land areas by the method of co-ordinates.

The formula as adapted to the use of figuring cross-sections considers a cross-section merely as an area, the co-ordinates of all corners of which are known—the cuts or fills being looked upon as ordinates and expressed in terms of y, the distances out from the center being looked upon as abscissæ and expressed in terms of x, and the area being A. The general formula for any conceivable shape of section would be



$$A = \tfrac{1}{2}\,[y_0\,(x_1 - x_n) + y_1\,(x_2 - x_0) + y_2\,(x_3 - x_1) + y_3\,(x_4 - x_2) + y_4\,(x_5 - x_3) + y_5\,(x_6 - x_4) + y_6\,(x_7 - x_5) + y_7\,(x_n - x_6) + y_n\,(x_6 - x_7)]$$

Stated in words, as the writer has often been obliged to interpret the formula for rodmen and others with little or no knowledge of algebra, the formula would real as follows:

"Begin at any point on the section and proceed in either direction (clockwise or counter-clockwise), multiplying each cut (or fill) in its order by the horizontal distance between the point just preceding and the point just succeeding. In cases where one passes to the right in measuring the horizontal distance from the preceding to the succeeding point the product obtained by multiplying this distance by the cut (or fill) at the intermediate point is of one sign and in cases where one passes to the left the product is of the opposite sign. Take one-half the difference between the sums of the products of opposite signs and the result is the area of the section."

A peculiar and valuable feature of the formula is that, while it is absolutely general, its application to the simpler sections shows up at once with little or no inspection the shortest possible way of computing the areas. Thus, in a side cut where only the slope stake reading and the intersection of the earth surface with the grade line are taken, the area is a simple triangle and application of the formula to the computation of the area would seem to require three multiplications. But one factor in each of two of these multiplications is zero because the points are on the grade line and the cut (or fill) equal to zero, and it is therefore necessary to perform only one multiplication and take half the product. Also in the case of the so-called "three-point section," or "three-level section," which is really a five-point section, two multiplications are similarly eliminated and two more (the outside slope points) can be worked together by first taking the sum of these cuts (or fills) and then multiplying by one-half the roadbed widths, which fact is apparent at once, because inspection shows that in every section each of the outside cuts (or fills) will be multiplied by half the roadbed width. Many more useful and interesting features of the application of the formula appear as one extends its use.

The formula is not an approximation, as slope and other formulæ so often are. It is mathematically exact and absolutely general. Nor is its application so difficult as the formidable appearance of the algebraic or word statement would indicate. It may be necessary for one in figuring the first few sections to draw rough sketches of the sections in order to make sure he is not confusing the order of the points, but a very little experience soon enables him to compute the areas from the cross-section notes directly without this help. The writer has on numerous occasions taught the formula in a few minutes to men with scarcely a grammar-school education. And he has on many more occasions found experienced and well-educated engineers obliged to plat each section, and then laboriously either break it up into triangles or run the planimeters over it to find in the end only an approximate area.

EVERETT N. BRYAN.
Modesto, Cal.

Simple Derrick Turntable for Erection Work

SIR: A few years ago while employed on an erecting job out in California we used a little scheme for a turntable that might prove of interest to other erecting men.

Materials for construction had been unloaded from cars along the railroad without reference to the position these parts were to have in the building, and for a time the haulage problem looked serious. However, permission was obtained from the railroad company for use of one of their push cars on their tracks. A wooden track was then built from the building with a couple of beams overlaying the steel rails. A derrick was placed in the corner at the intersection of the railroad siding and the wooden track. Each load of material was pushed under the derrick on the steel rails, a chain was wrapped around the car and load, and the whole picked up about a foot. The wooden beams that served as rails were then slipped beneath the car, the car was twisted through 90 deg. lowered to the wooden track, and the trick was accomplished. Much money was saved by this simple turntable device.

N. G. NEAR.
New York.

THE FORMULA on page 404 of the issue of Oct. 10, at the end of the article "True Pressure Line in a Masonry Arch," which begins on page 401, was in error. It should read $p = 2\,P/3\,(h/2 - e)$ instead of $p = 2\,P/3\,(h/2 - 3)$.